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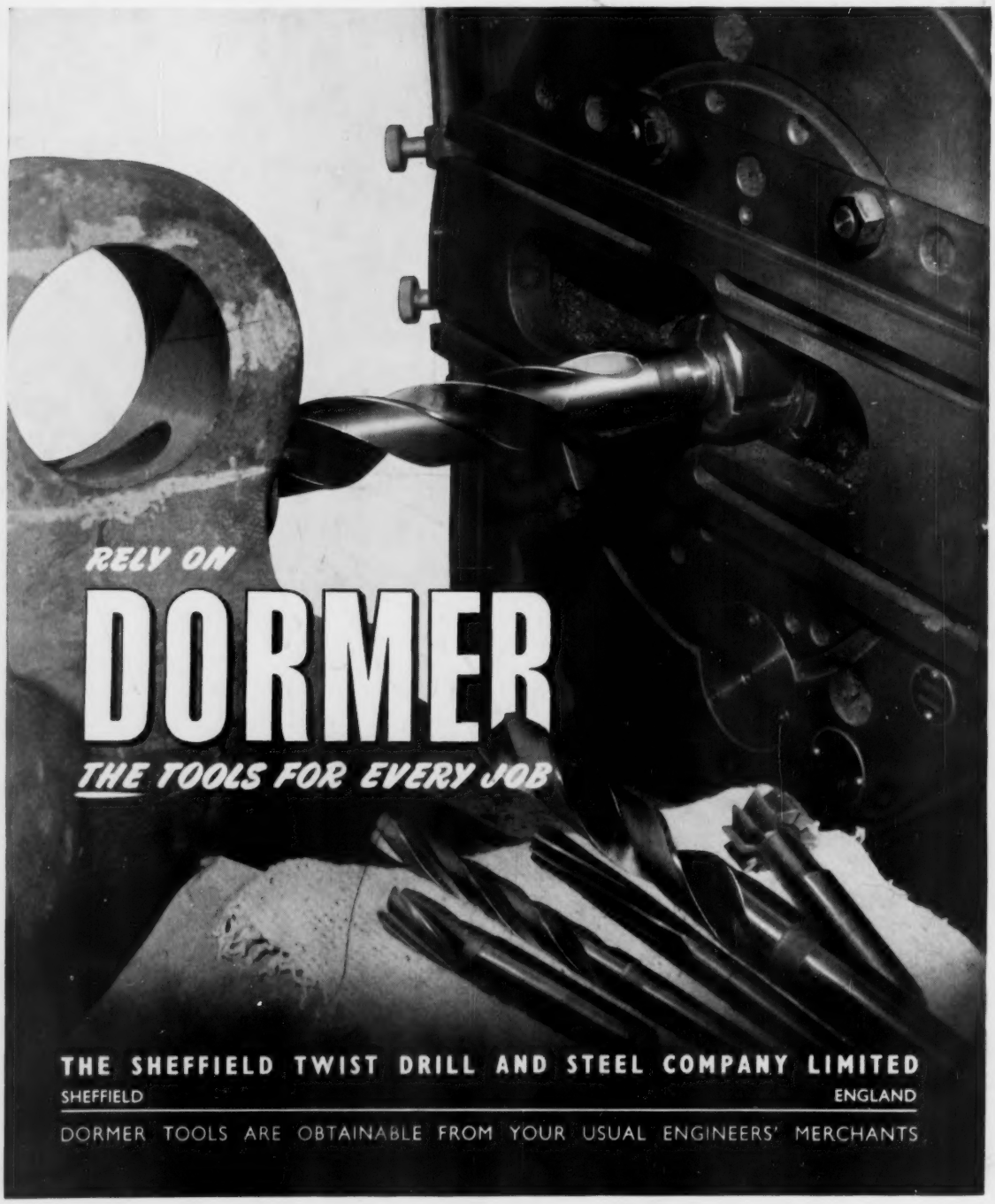

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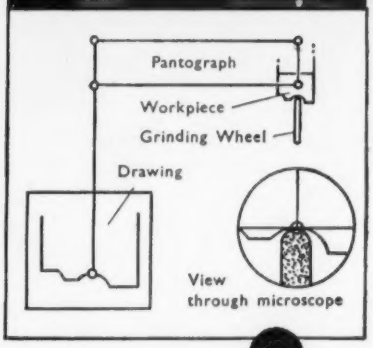

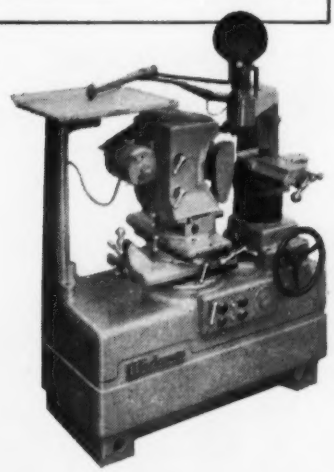

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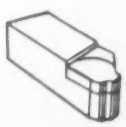

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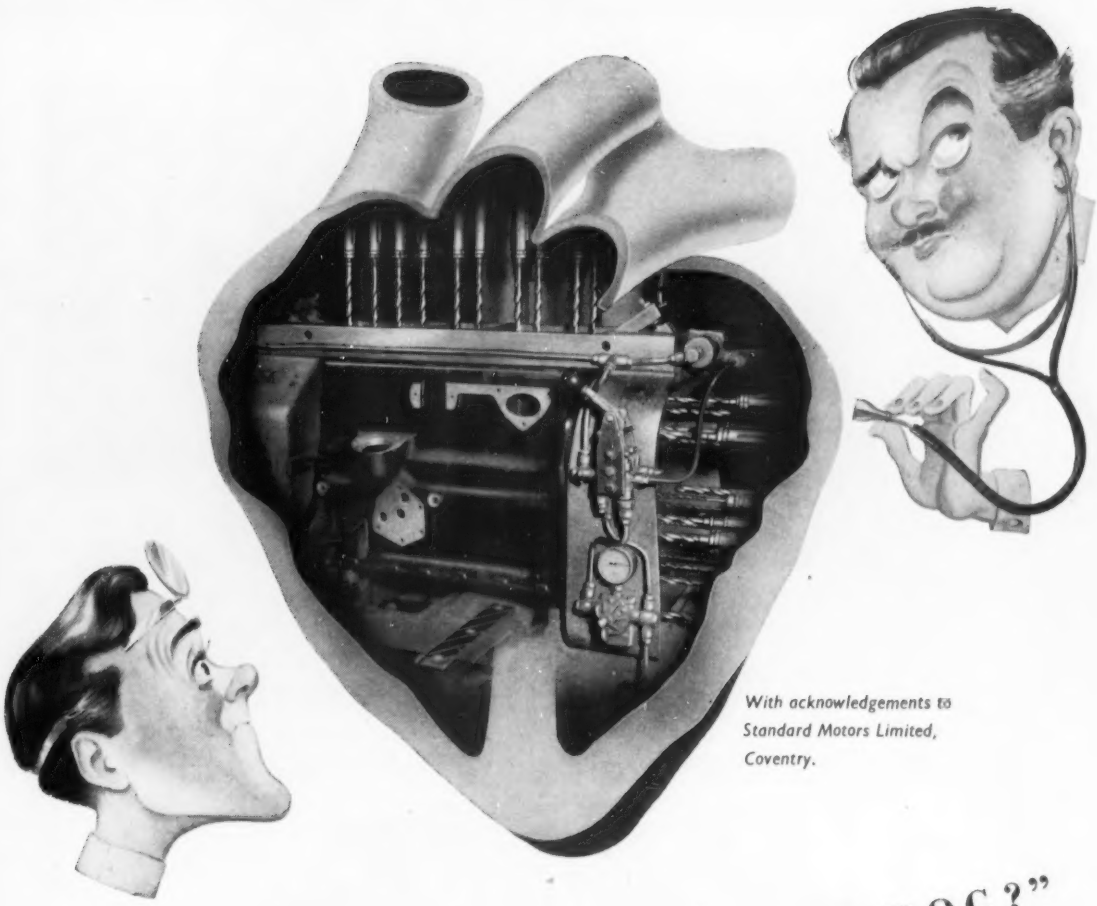

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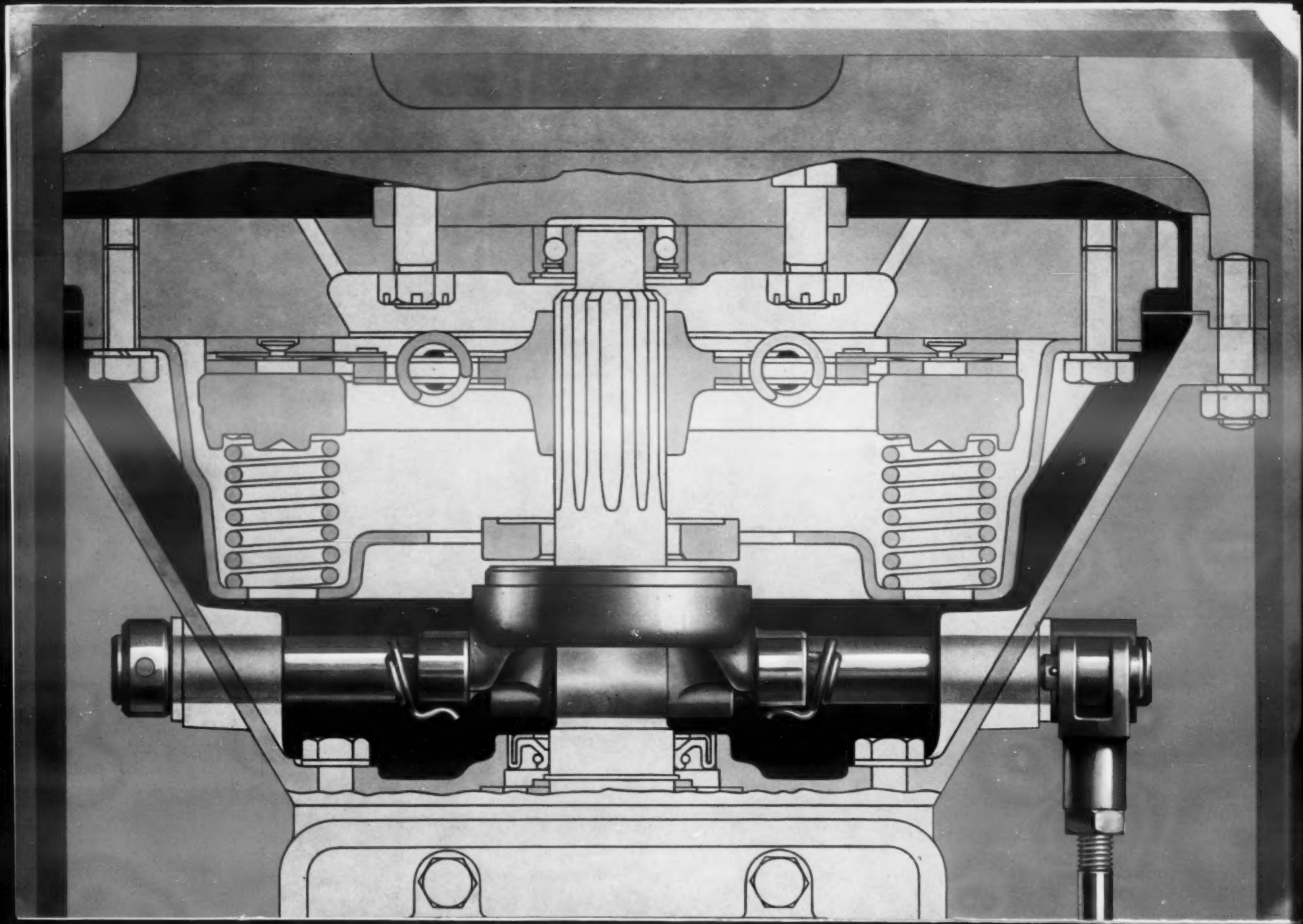

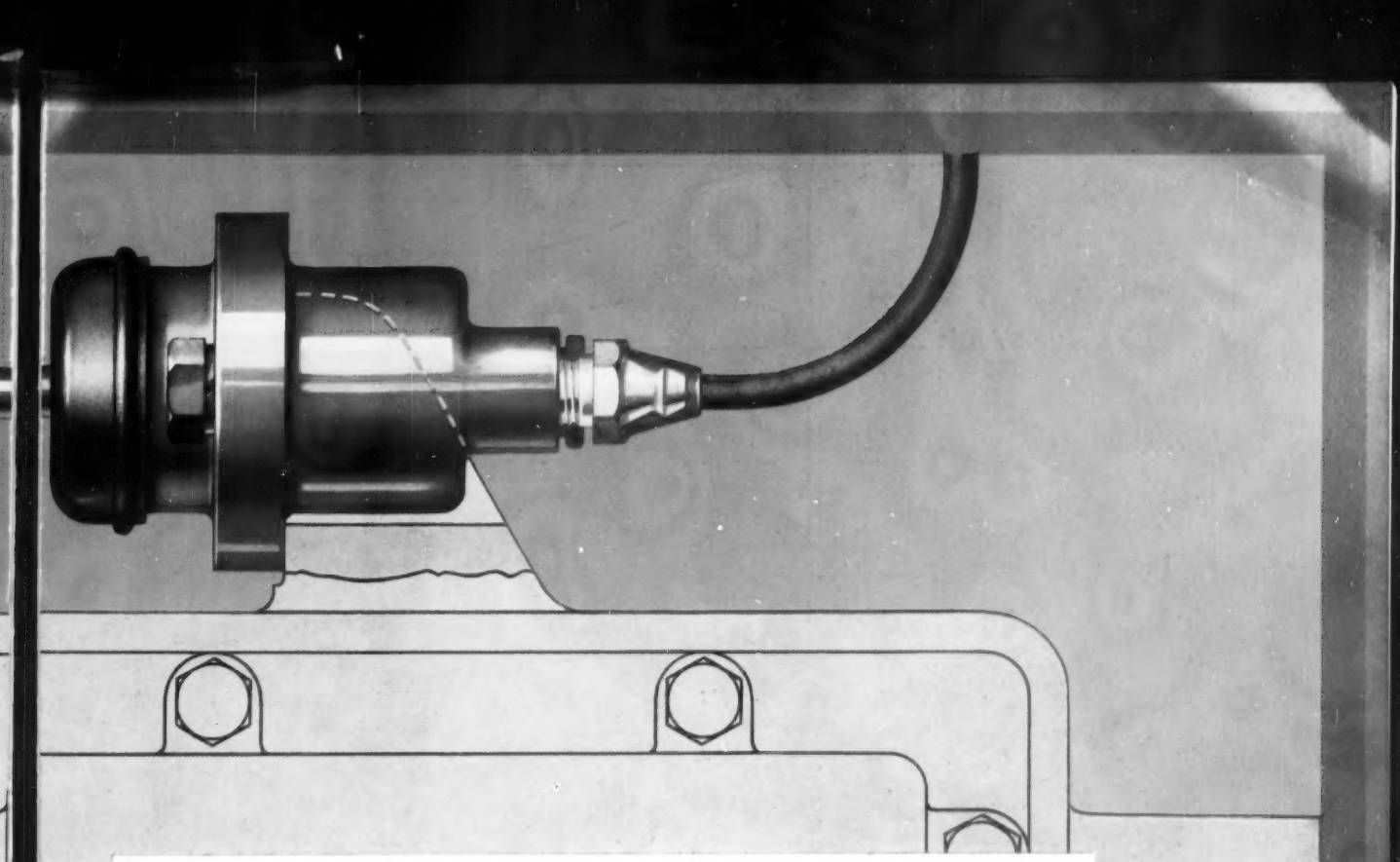

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The diagram shows the application of the Lockheed hydraulic clutch actuation to a standard Borg and Beck clutch. In this system, the master cylinder is one of Siamese twins, the other master cylinder serving the Lockheed hydraulic brake.

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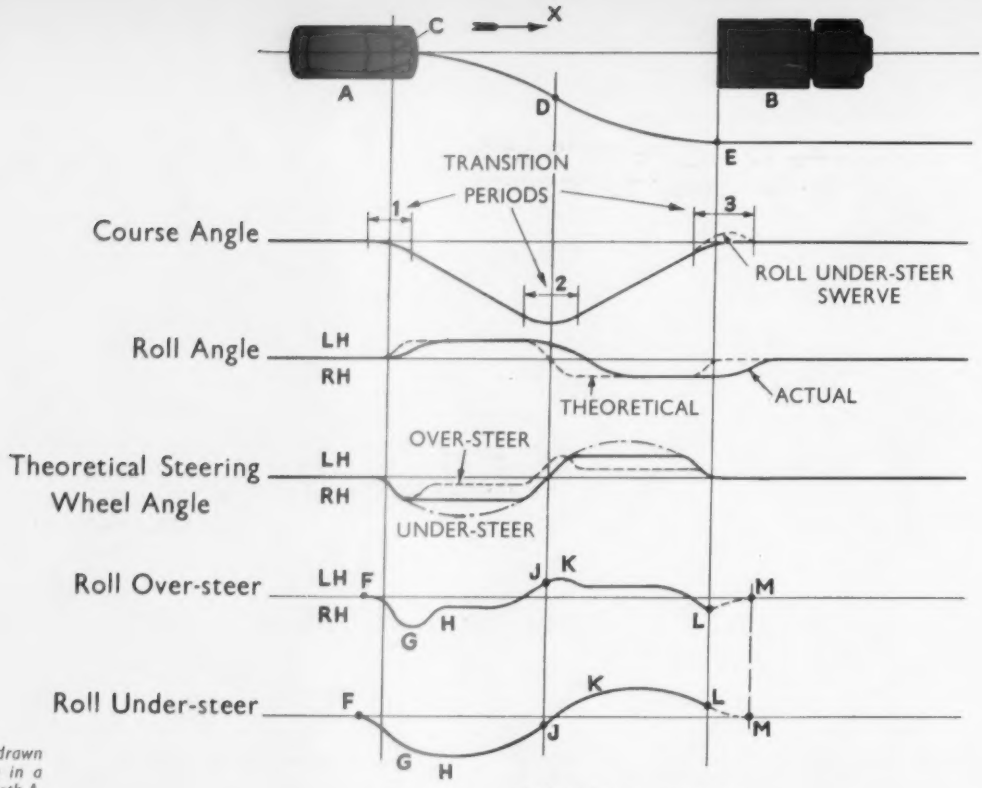

Illustration redrawn from diagram in a paper by Kenneth A. Stonex.

PASSING A TRUCK

SUBTLETIES OF STEERING

The Transient Stage: 1. Introduction

In these essays we have so far only considered the factors that affect the steering or handling behaviour in steady conditions, i.e., when rounding a curve of constant radius at a constant speed. Experiments to study handling behaviour were in fact first made in such steady conditions on a steering pad, a flat concrete disc of rather over 250 feet diameter, such as is now available for use by member firms at the Motor Industry Research Association proving ground near Nuneaton. These early experiments served to show the effect of various car and tyre factors on the car behaviour in such steady conditions, and enabled a valuable fund of knowledge to be built up.

Unfortunately, at least for the experimental engineer with ideas of a simple life, cars do not spend their time rounding curves of constant radius at constant speed. Just as the highway or railway engineer joins one curve to another or to a straight by a transition curve, so a car passes through a transient stage between one set of steady conditions and another. During this transient stage factors additional to those we have already considered influence the steering behaviour of the car. The first description of a method of studying car behaviour in the transient stage was contained in a paper "Car Control Factors and Their Measurement" by Kenneth A. Stonex, which was published in the 1941 S.A.E. Transactions. He called his method 'The Checkerboard Test'. A car which had a movie camera on the roof aimed at a point about 20 feet in front of the car, and which also had dials showing front wheel and rear axle steering angles mounted in the camera field of view, was driven over a 'checkerboard' surface to simulate a swerve from one traffic lane to another alongside it. From the resulting exposures the roll, course and pitch angles were deduced and plotted for the whole manoeuvre. If a car subjected to this test has had its behaviour previously investigated on a steering pad, the differences between steady and transient condition behaviour can be arrived at and studied to try to find the reasons for their existence.

Although Stonex gives in his paper the results for one car only at only one speed it is nevertheless profitable to stop and look at his results, and at the comments made on his method by Olley in his I.A.E. Paper "Road Manners of the Modern Car" (Proc. I.A.E., Vol. XLI).

As one would expect, although front slip angle — and hence front sideways acceleration — increase fairly rapidly (the former more quickly than the latter), the arrival of rear slip and rear sideways acceleration is delayed, as also is roll angle build-up. Steering wheel angle divided by the overall steering ratio is appreciably more than the front wheel angle, showing the existence of steering 'sponge'.

The fact that sideways acceleration builds up more slowly than drift angle implies that there is some delay in the development of cornering thrust. It must take a little while in any case to establish the proper pattern of tread elements in relation to the road, and this may be the main reason for the lag in the sideways force increase. Quite apart from this lag, however, there are other reasons for the apparent non-agreement of car behaviour in steady and transient conditions, the principal ones being due to the introduction of the car inertia as a factor. This, for instance, is seen to be responsible for the gradual build-up of roll angle, and hence the delay in introducing any roll-steer effects into the car behaviour.

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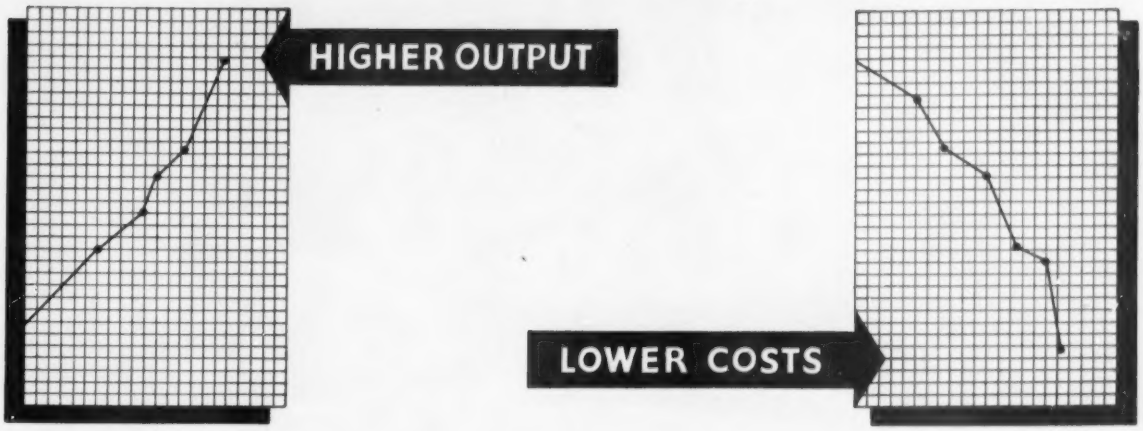

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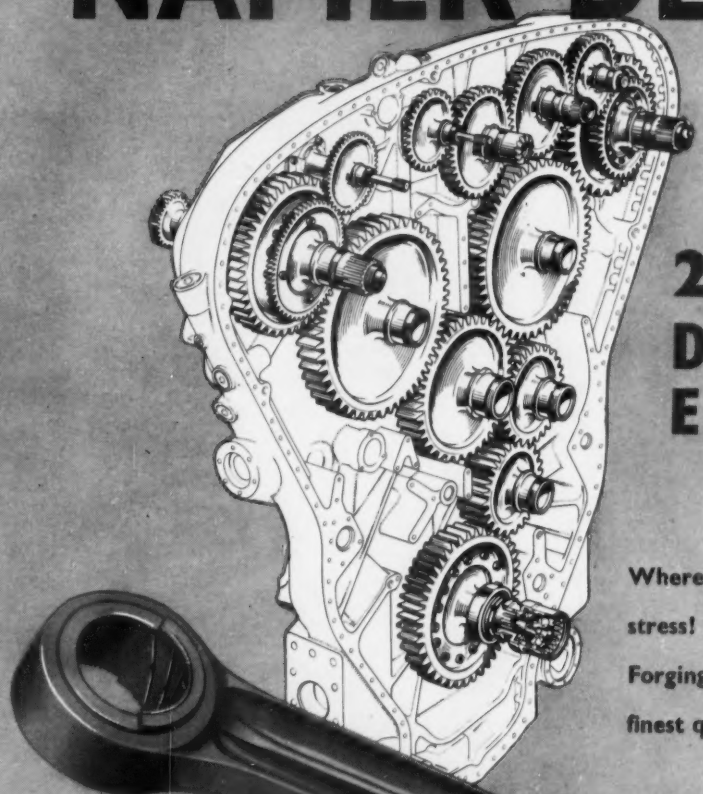

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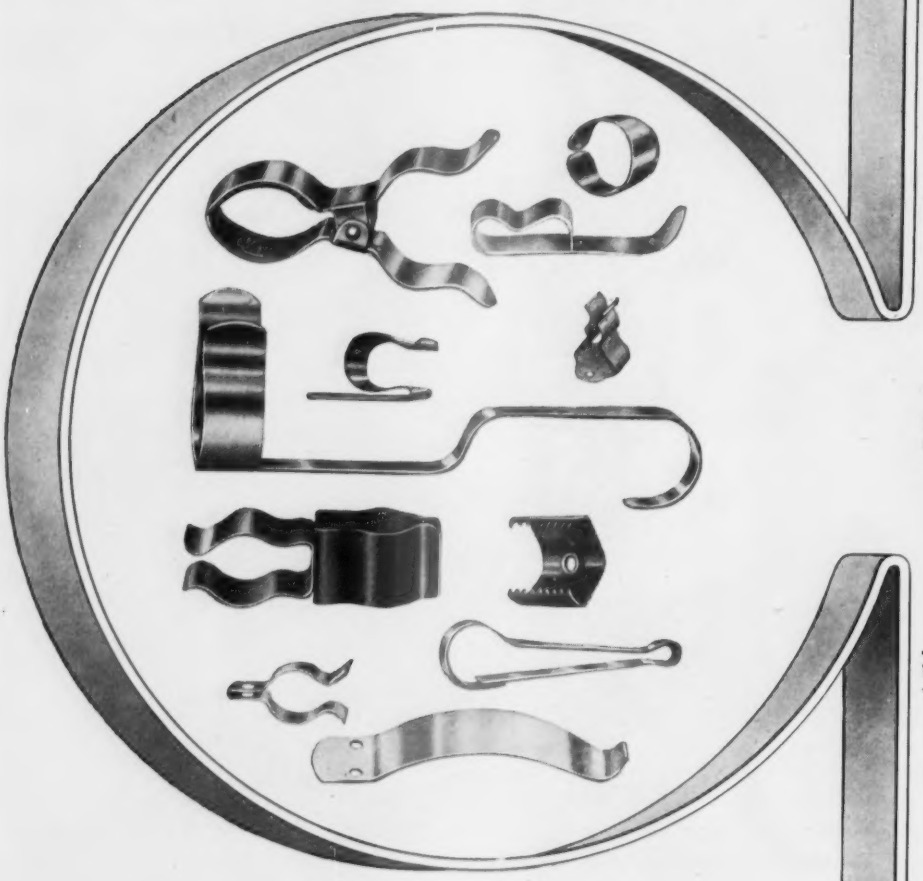

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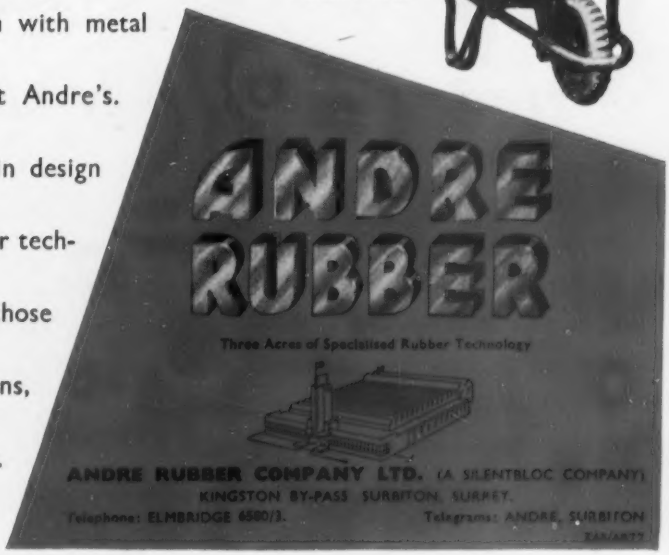
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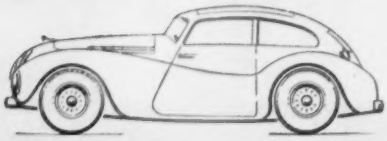

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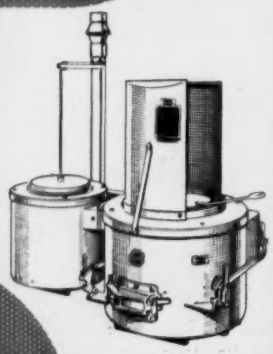

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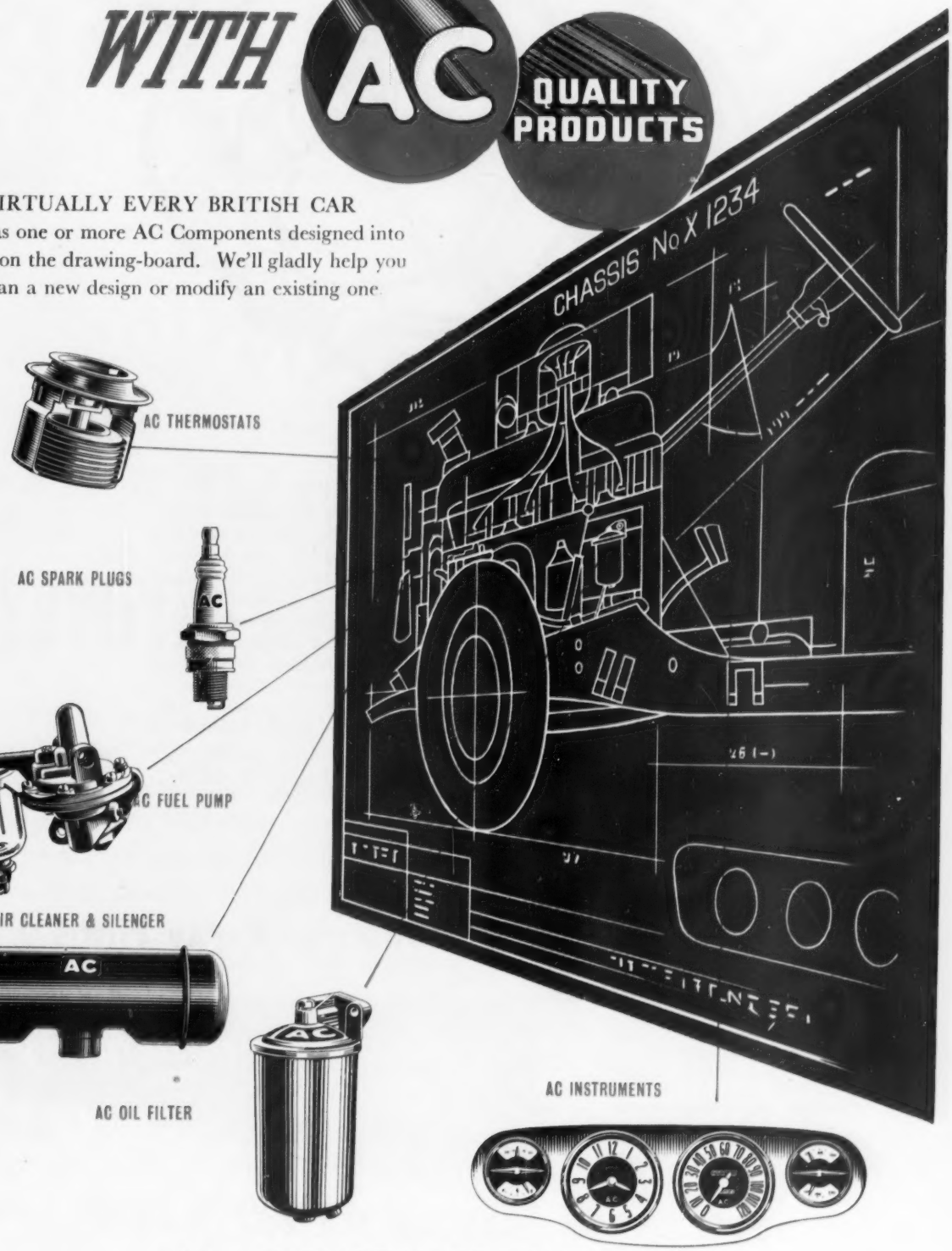

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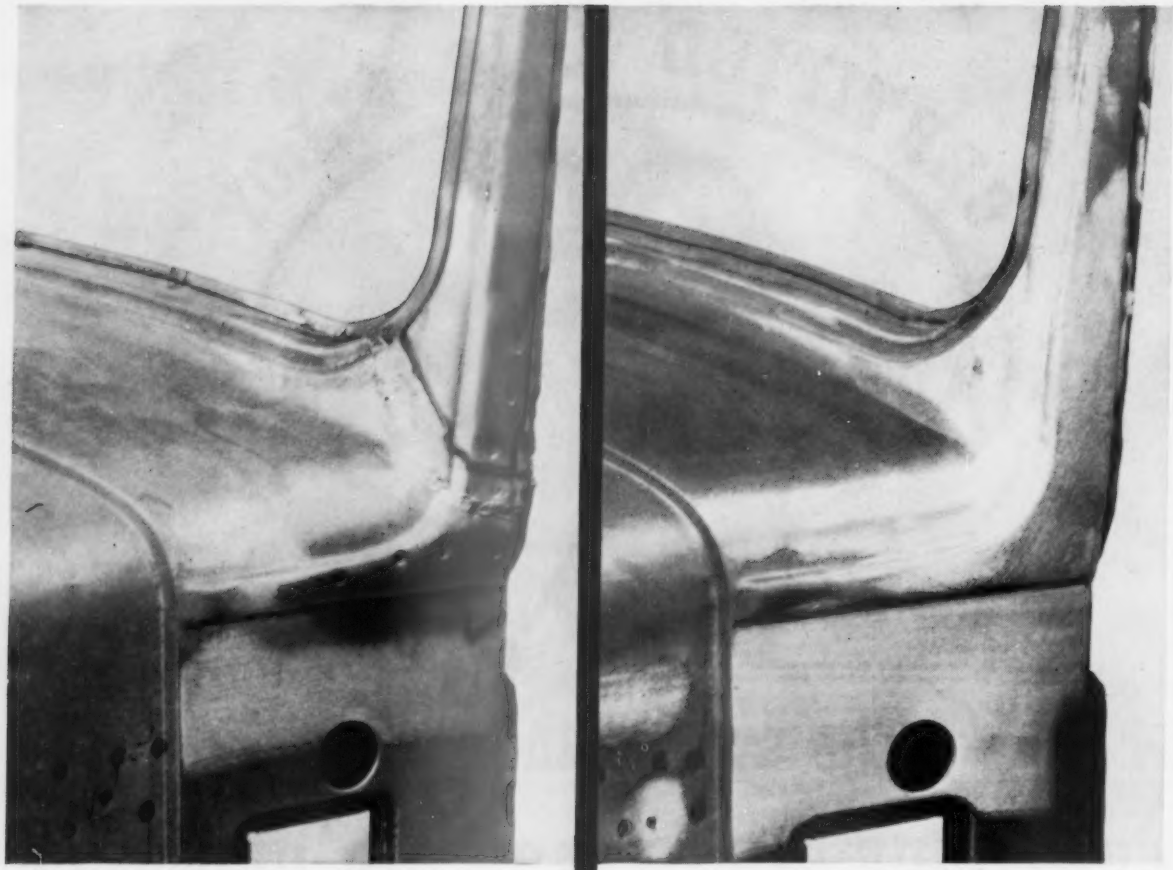

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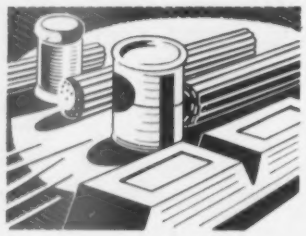

Our technical advisers and laboratory staff are available for consultation. Technical data, descriptive literature and samples will be gladly sent on request.

ENTHOVEN SOLDER PRODUCTS

ENTHOVEN SOLDERS LIMITED, 89, UPPER THAMES STREET, LONDON, E.C.4. Telephone : MANsion House 4533. Telegrams : ENTHOVEN PHONE LONDON
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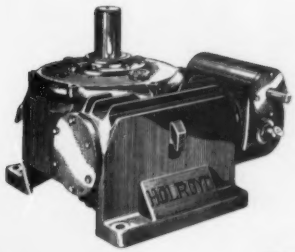
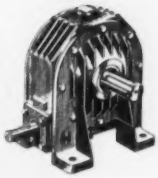
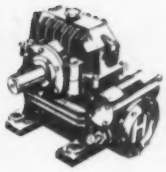
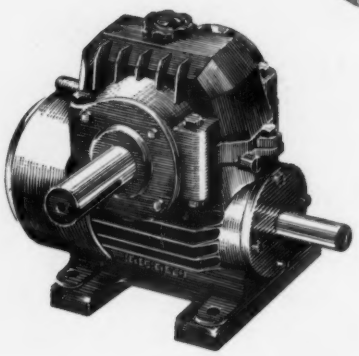
the things they make at Holroyd's



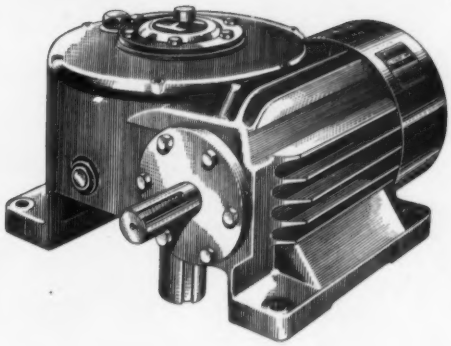


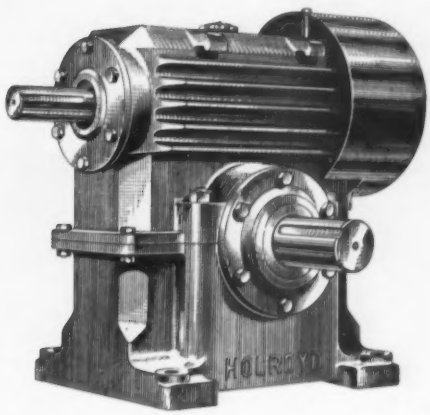




THEY'VE WRITTEN A BOOK ABOUT THEM

Holroyd's have written a book about their Worm Gear Reduction Units. It gives full details on their Underdriven, Overdriven and Vertical Type Units — selection and service, horsepower and torque, dimensions, efficiencies, lubrication and maintenance — all the facts a worm gear user needs. They'll be glad to send you a copy, together with information on the other three kinds of Worm Unit shown above, (the 'F' and double reduction types). Their address is John Holroyd & Co., Ltd., Milnrow, Lancs.





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CBC 163

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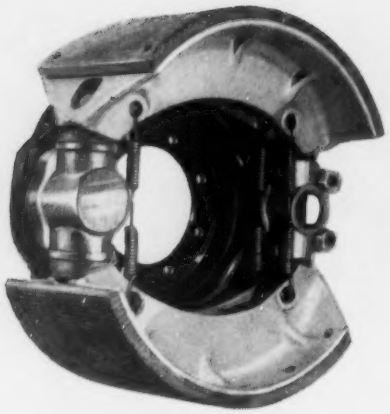

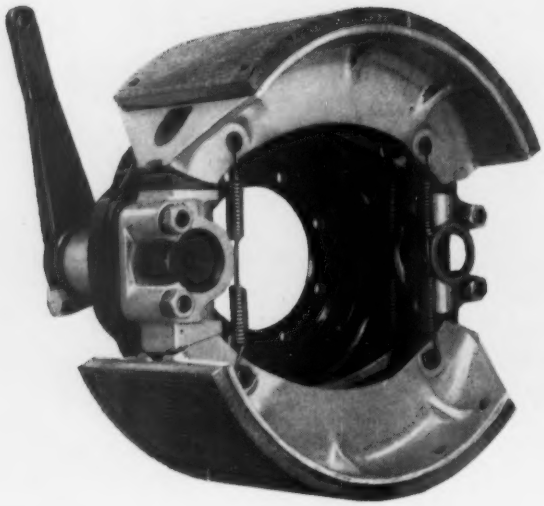

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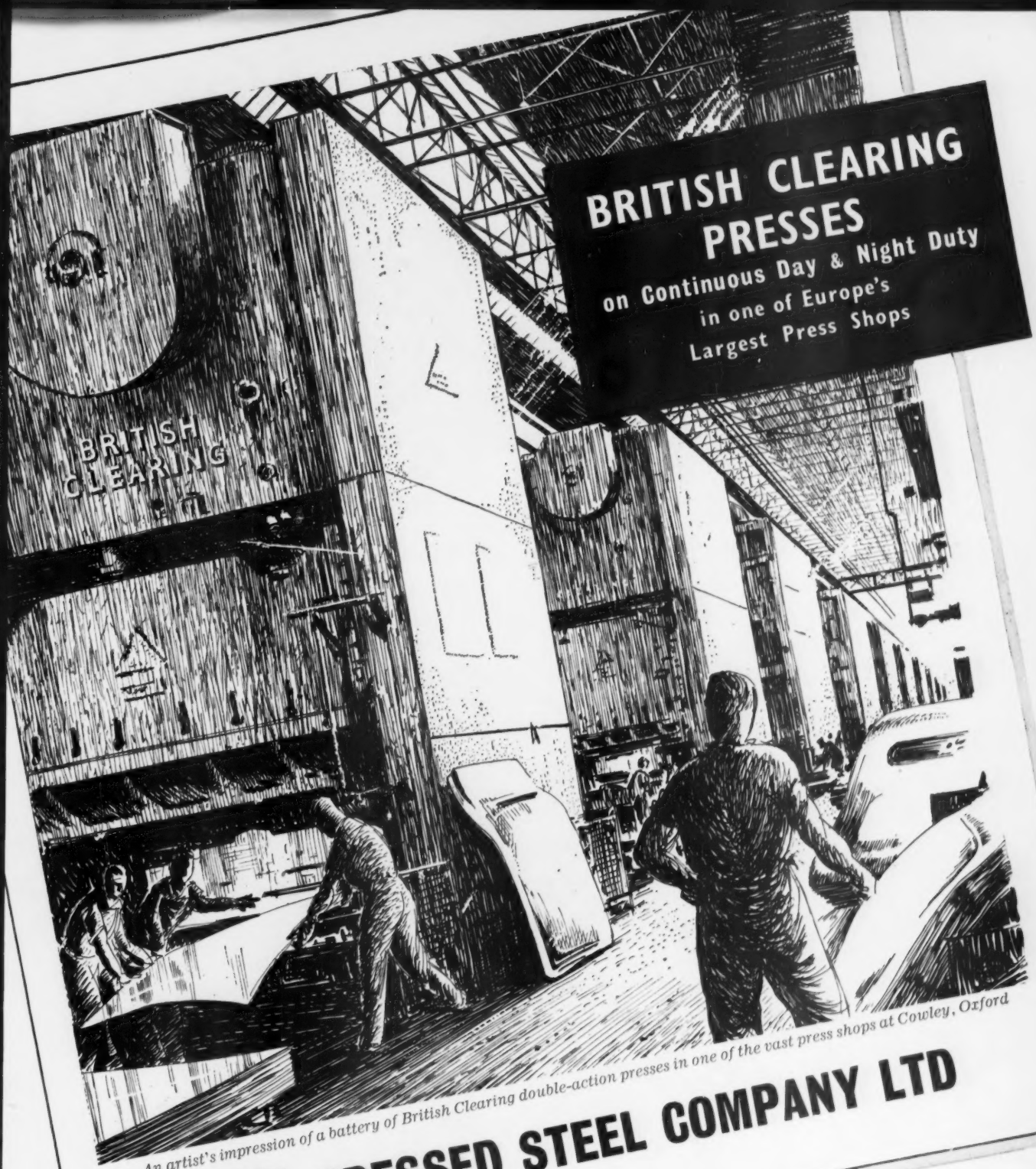

An artist's impression of a battery of British Clearing double-action presses in one of the vast press shops at Cowley, Oxford

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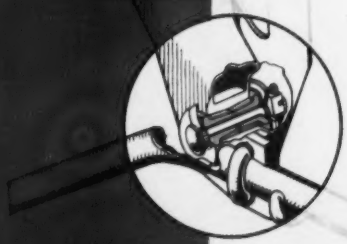

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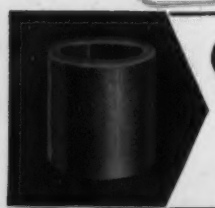
Where bearings and bushes are being used production output can be increased and production costs reduced by specifying Compo and Powdiron. These self-lubricating, anti-friction bearings are produced by the powder metallurgy process, formed in hardened steel dies. They are finished to very close tolerances and supplied ready for press fitting without reaming or machining. Furthermore, their oil impregnation dispenses with oil grooves, oil holes or lubricators. Specify Compo and Powdiron and speed up *your* plant production.



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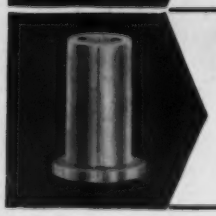

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A comprehensive range of standard cylindrical bushes is available from stock

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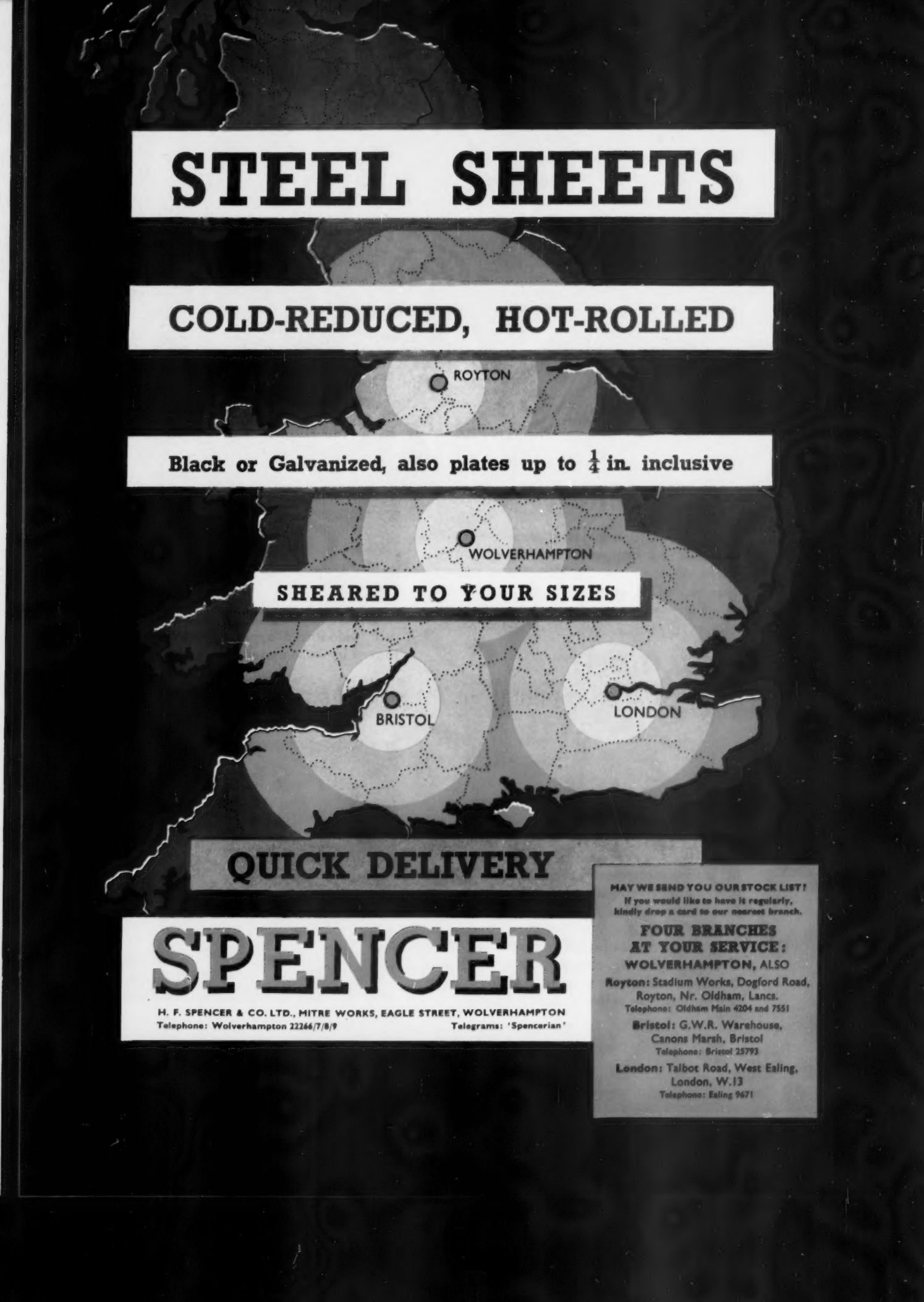
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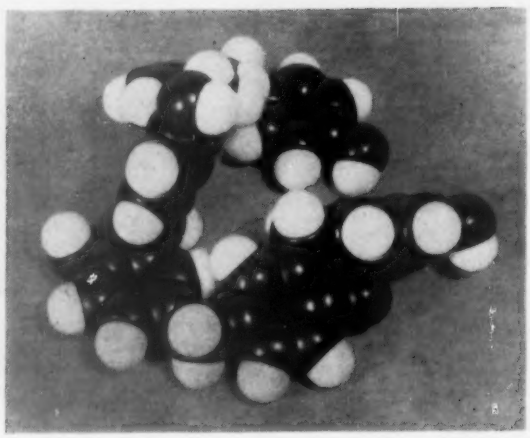
When Mr. Jones Puts his Foot down . . .

. . . if he's an average motorist, the brake he applies is Ferodo lined. This is true, whether his car is new or pre-war, for not only do the majority of manufacturers specify Ferodo linings for their new models, but most garages, too, use Ferodo for all re-lining jobs. There must be a reason for such wide-spread approval. Why are Ferodo Brake Linings so universally preferred?

FERODO FACILITIES FOR RESEARCH &

IT BEGINS IN THE TEST TUBE

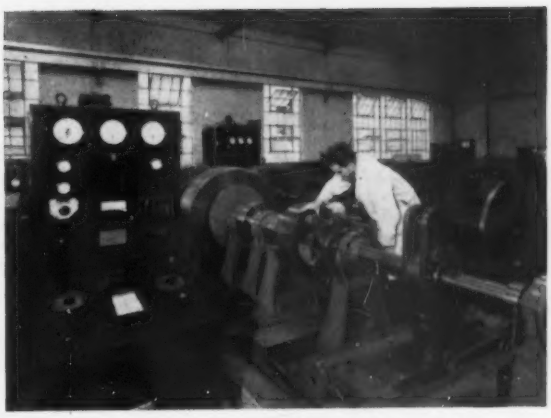
In the Ferodo chemical research laboratories there is continual investigation into the properties of basic materials. The fibre structure of different kinds of asbestos . . . the molecular structure of the phenolic resins used for bonding . . . all this is studied, confirming, rejecting, amplifying traditional knowledge. The result is the ability to select and use materials to their greatest advantage.



Model of the molecular structure of phenolic resin before curing

NEXT—THE TEST HOUSE

Here the inherent qualities of a material and its potentialities as a brake lining are assessed. Test machines, free from the vagaries of weather, driver and road conditions give concise, accurate results. Many new recording instruments have been introduced, like the radiation pyrometer, with a response time of a few thousandths of a second. The Test House is also used to check sample linings from actual production batches. Thus both present and future standards are protected.



A view of the Test House, showing the three-shoe brake lining assembly

One of the Ferodo Test Fleet cars

FINALLY—THE TEST CAR

The Ferodo Test Fleet contains vehicles of all kinds, and new models are constantly added. Test drivers, using their cars as a chemist uses his laboratory bench, observe and record the performance of sample linings under every kind of road condition.

All the intense research and endless testing carried out by Ferodo scientists and technicians reaches its culminating point when the average driver puts his foot down. The car stops smoothly, safely . . . Ferodo thoroughness has proved its worth.

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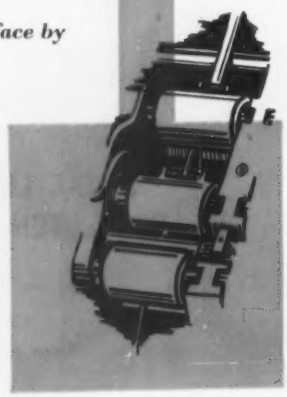
The Eyrie of the Eagle, *high perched on mountain ledge where neither beast nor man may violate the privacy of its nursery, presents a picture of inaccessibility. Overcoming this problem in the industrial field is made easy by the employment of "Reservoil" sintered-metal oil-retaining bearings, so that where maintenance for lubrication is difficult or undesirable, oil is fed automatically to the bearing surface by capillary action.*



Textile Machines are an instance where 'Reservoil' bearings can be used to advantage. These bearings are supplied in shapes and sizes for every normal medium duty, but attention is drawn to the range of plain cylindrical bearings to B.S.I. Standard dimensions. Write for Catalogue SD40.

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Exhaustive tests at high speeds and production and use over a long period have proved the suitability of Darcast Flywheels in high duty cast iron for petrol and diesel engines and for compressors. Long specialised experience ensures homogeneity in the castings which is necessary to obtain uniform density with perfect balance, while the machining faces are free from hot-crazing and suitable for friction clutch operation. Our current production covers a wide range 7″ - 24″ diameter and 8 - 300 lb. weight in irons with a tensile strength of 15 - 24 tons per sq. in. Strict metallurgical control maintains the high quality of the material and advanced methods of mechanised production keep the cost of castings at the minimum. An interesting new leaflet is available on request.

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SMETHWICK 40 BIRMINGHAM

7 days quicker by Gloucester!

ANY other foundry needs 9 days to anneal blackheart malleable castings. But Gloucester Foundry can anneal in 48 hours! The secret is the advanced new elevator-type electric furnace at Gloucester—the only one of its kind in Britain. This means you can have delivery of the first castings within 72 hours.

Gloucester Foundry is fully mechanised for high outputs of blackheart malleable and grey iron castings. Their foundry experts will gladly advise on the design of castings to make the most of the malleable technique. Call them in early while the job is still on the board.

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SEE OUR EXHIBIT
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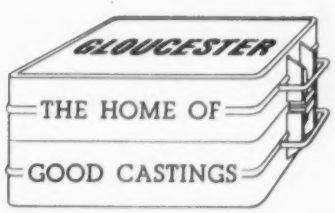


100,000 MILES WITHOUT A RE-BORE!

This hard driven newspaper van still gives 1,800 miles per gallon of oil!

Wellworthy Oil Control Rings Reduce Oil Consumption Without Increased Bore Wear

THE Duaflex oil control rings have recently been given a thorough practical test by the fleet of the "Birmingham Post and Mail". The results have been remarkable.

26 Vans Average 59,400 miles without re-bores

Since April 1948, twenty-six vans have been fitted with Duaflex rings and between them have completed 1,545,000 miles without a re-bore. One has exceeded 100,000 miles and five are close to the 90,000 mark. And that means a real saving.

This has been achieved with 48 sets of Duaflex rings — a considerable saving over the cost of re-bores which would normally have been required, quite apart from the time saved on servicing operations.

Mr. J. Jennings, responsible for the maintenance and servicing of the 'Post and Mail' fleet of more than 100 vans, is delighted with results obtained from Duaflex rings. "Newspaper delivery vans are notoriously hard worked" he says "but Duaflex have stood up wonderfully to continuous stop-start driving and show a great saving in maintenance time and costs".

In the notoriously hard driving conditions imposed on newspaper vans these rings have proved themselves a vital factor in the economy of fleet operations.

HOW DUAFLEX RINGS WORK

The principle of Duaflex rings is unique. They are designed to expand in two directions; vertically, to seal the rings in their grooves; and outwardly to press against the cylinder bore. In this way an oil and gas-tight seal is maintained between piston and cylinder wall.

SECTION THROUGH RING

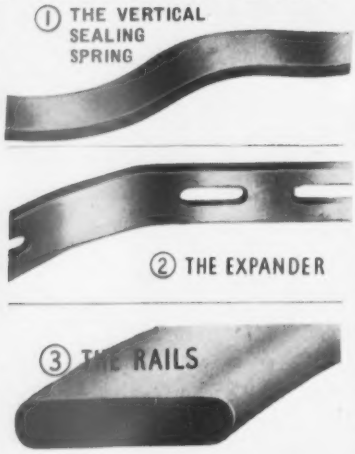
Three Exclusive Features

The vertical sealing spring (1) seals the ring in its groove. The "Expander" (2) maintains an even outward pressure ensuring perfect contact with cylinder walls however worn or distorted the bore may have become. And the rails (3) are designed to 'wipe' oil from the cylinder walls and avoid scraping and consequent wear.

Chrome plated for longer life

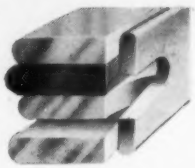
Further protection for cylinders and rings is provided by chrome plating. The wear-resisting qualities of chromium plate and its resistance to corrosion means longer life for both cylinder bores and the rings themselves.

DPR 1



Special rings for chrome plated bores

Like all chrome plated rings the new Duaflex is not suitable for use in chrome plated bores. A chromium plated bore will not retain oil to the same extent as a cast iron bore, and this factor, coupled with the very efficient wiping action of a Duaflex ring, may lead to dryness in the cylinder, with the possibility of seizure. So a special Duaflex Ring — "The Gold Line" has been evolved to bring all the advantages of Duaflex rings to chrome plated bores. The "Gold Line" Duaflex may be used with great advantage and perfect safety in engines using chrome plated liners. As the illustration shows, in the "Gold Line" version one of the rails is of bronze and projects .002" beyond the others so that it initially smears the bore with bronze. This coating of bronze assists the lubrication necessary for the critical period of "bedding-in".



DUAFLEX OIL CONTROL RINGS

REDUCE OIL CONSUMPTION · INCREASE COMPRESSION · DEFER RE-BORES

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ZINC

Almost as quickly as you can say the words " Think Zinc," molten zinc alloy has become the Plessey gramophone record-changer base you see here. This speed in production is just one reason why in recent years so many industries have adopted the zinc alloy die casting process. Other outstanding advantages are :—

SCOPE FOR DESIGNER · EXTREME ACCURACY · GOOD CORROSION RESISTANCE · STABILITY STRENGTH · LONG LIFE OF DIES · LITTLE NEED FOR MACHINING · LOW UNIT COST

The Association welcomes inquiries about the use of zinc alloy die castings. Publications and a list of Members are available on request. We suggest you write for our booklet "Zinc Alloy Die Castings and Productivity."

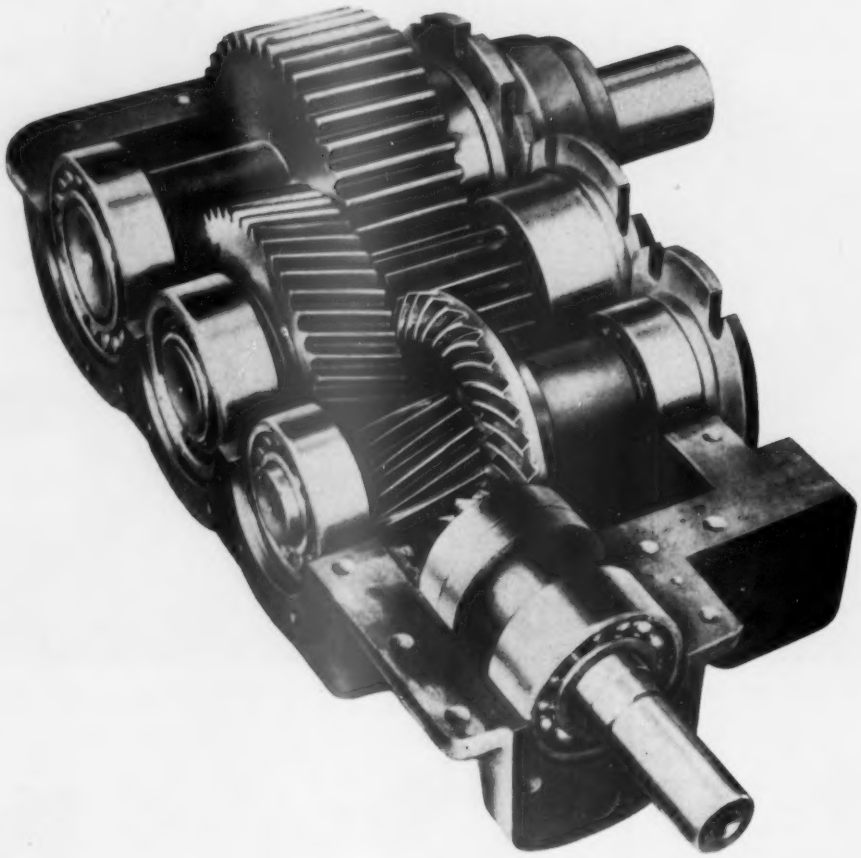
Zinc is now plentiful. There are no restrictions on its use.

ZADCA

ZINC ALLOY DIE CASTERS ASSOCIATION · LINCOLN HOUSE · TURL STREET · OXFORD · TEL: 48088

REGISTERED TRADE MARK

If it's a "running" job...



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X-ray of Rubber Trunnion Block showing steel mesh rubber bonded centrebush.
No Sliding Spline.
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The fluidity of Ley's 'Black Heart' malleable, when casting, leads to fluidity in design, with the assurance that the finished part is tough and resistant to impact, yet easily machinable. Here is a hub, 12½-inch diameter, for a well-known commercial vehicle, meeting design requirements to a degree unattainable with other materials.

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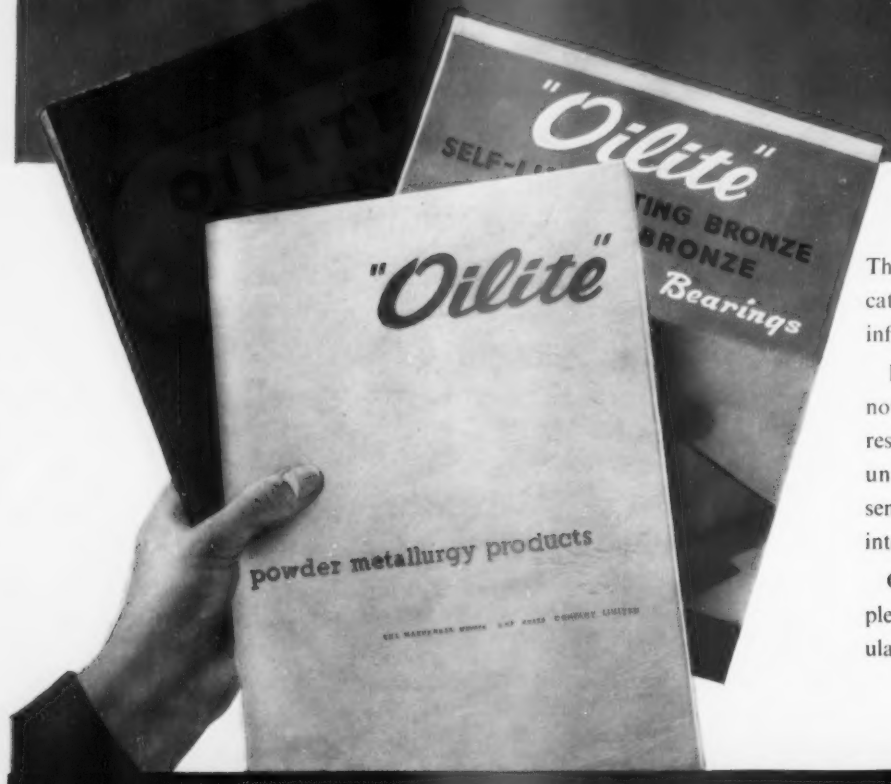
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Pah Tools? YUS—I've heard of pah tools. I've ***seen*** pah tools. 'lectric ones! Pewmatic ones. Piddlin' things like what you'd give your kid to play wiv. You don't get me usin' no pah tools. I must of screwed a 'undred million screws in by 'and and I ain't startin' no pewmatic doodahs. Pah tools are faster? Oo ***wants*** to be faster? Easier? Work wasn't meant to be easy, mate. Work 'as to be 'orrible or we shouldn't want to stop! You bin readin' them Desoutter ads mate, that's wot you bin doin'. You don't want to be led away by no adver***tise***ments. Stick to your screw-driver, mate, and go 'ome tired of an evening, same as me. ***Desoutter! Pah!***

Desoutter Bros, Ltd., The Hyde, Hendon, London, N.W.9 Telephone: Colindale 6346 (five lines) Telegrams: Despnuco, Hyde, London.
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*'Syndromic' Automatic Lubrication soon pays for itself!

*INCREASES YOUR PAYLOADS 10%

From the moment you equip your vehicle with 'Syndromic' Lubrication it begins to pay for itself! First, it saves up to 75% on lubrication costs. Then, it ensures less wear on bearings because it automatically lubricates up to 80 bearings (using 2 pumps) at periods controlled by mileage. As a result, maintenance and replacement time and costs are kept down to a minimum.

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Ask for a Tecalemit technical representative to call and discuss the 'Syndromic' system with you.

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T416

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FOR THE MOST EFFICIENT MACHINING OF
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FOLLOWING extensive research into the fundamentals of Cemented Carbide production, and particularly the effects of grain-size control, Cutanit Grade I.C.C. has been developed in a greatly-improved form that is already establishing a high reputation for the most efficient machining of cast iron, malleable iron and chromium irons. The advantages also extend to the cutting of non-ferrous metals such as brass, phosphor-bronze, zinc and aluminium alloys, as well as plastics and other non-metallics.

The new Cutanit Grade I.C.C. is unexcelled for the general purpose machining of these short-chip materials, particularly where the emphasis is on high production rates.

For Maximum Performance Cut with Cutanit TRADE MARK CEMENTED CARBIDE A METRO-CUTANIT PRODUCT

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Let's get this question of 'Woven or Molded' straight

Preference MAY enter into it

but — straightforward NEED decides whether woven or molded brake liners should be fitted. (Note: — WE CAN SUPPLY BOTH). It takes you, to weigh up the various points (the type of vehicle, its braking equipment, and the conditions under which it is likely to be operated) that decide which precise quality of either type is required. And that is where we can advise. Our range of both *molded and woven* liners will meet the braking needs of any vehicle: and our Technical Staff will see that you get the *right* liner for the job.

...fit **Don** BRAKE LINING *to be* **sure**

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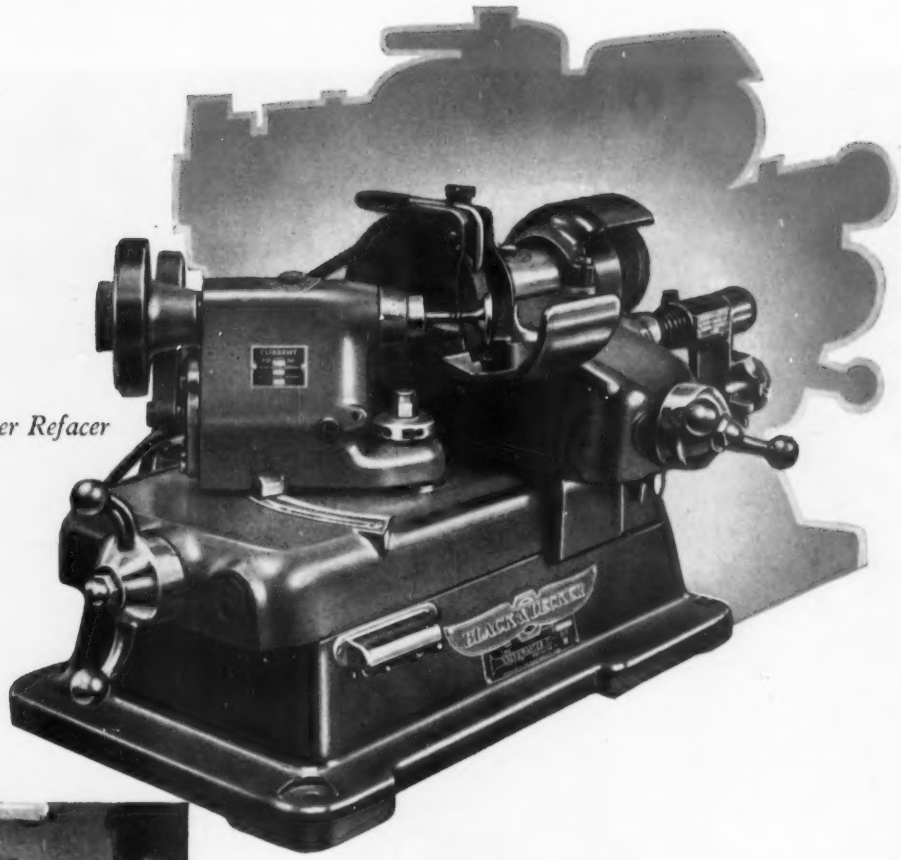
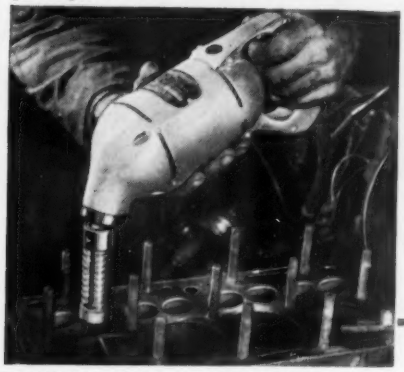


Valve Master Refacer

***The B&D Valve Shop** incorporates the Valve Master Refacer, the Vibro-Centric kit and the Carbon Removing kit in a transportable cabinet.* ***The 55° Vibro-Centric** Valve Seat Grinder used for working in confined spaces.*



OF COURSE YOU KNOW...

. . that badly matched or pitted valves destroy the smooth running of an engine . . . reduce power . . . increase petrol consumption—but DO YOU KNOW that the quickest, easiest and best way of righting all valve faults is with B&D equipment. The Valve Master Refacer refaces a set of valves to any angle with mirror-smooth finish in a matter of minutes and with an attachment grinds tappets, rocker arms and Ford Valve Stems! Its sister tool the 'Vibro Centric' valve seat grinder ensures a perfect match between valve and seat every time!

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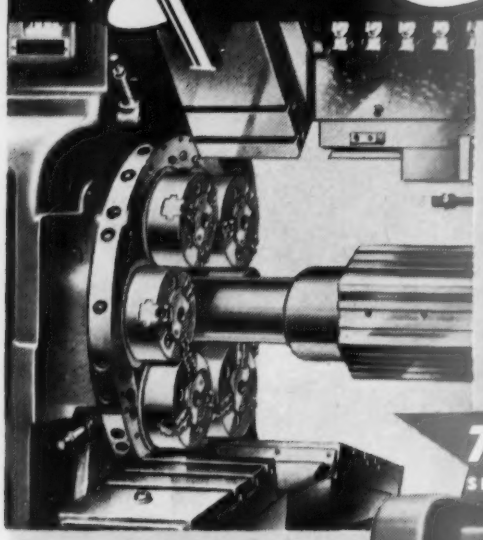
Wickman

Introduce

2 Large Capacity Chucking Automatics

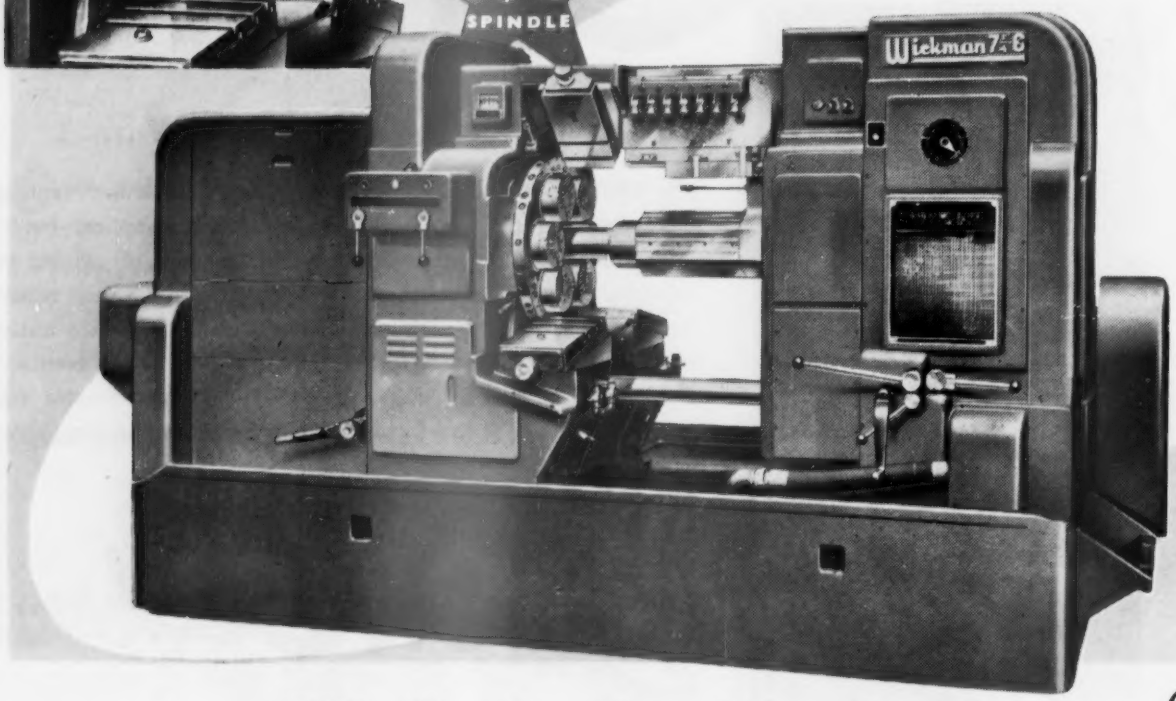


These machines offer new opportunities for fast, accurate, and economical machining of castings, forgings, billets and pressings.

They incorporate speed and feed ranges suitable for the widest possible field of use; the rigidity and power for machining tough materials, and the employment of tungsten carbide tooling; and the Wickman Autosetting mechanisms by which tool feed strokes can be set merely by the adjustment of lever mechanisms, without cam changing.

Inherently accurate, trouble-free and easy to service, and backed by the experience and advice of Wickman tooling and engineering specialists, Wickman Multi-Spindle Automatics provide a ready answer to the universal need for higher output and lower costs.

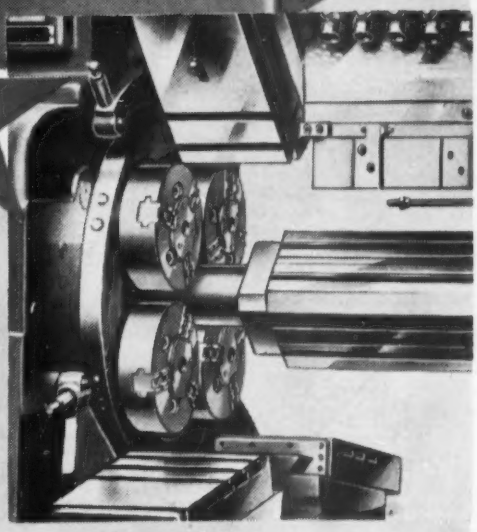
7¼"-6 SPINDLE



WICKMAN *of*

WICKMAN LIMITED, MACHINE TOOL DIVISION, BANNER LANE,

9"-4 SPINDLE



A wide range of standard toolholders is made for all normal types of tool in all stations, and standard attachments are available for high speed drilling, independent reaming, threading with self-opening revolving diehead, or threading with solid taps and dies.

The 7¼"—6 Spindle machine can be supplied arranged for double indexing if required.

PRINCIPAL DIMENSIONS

	7¼"—6 Spindle	9"—4 Spindle
Chuck diameter and maximum swing	7⅛"	9"
Feed stroke on main tool block..	0—5"	0—5"
Feed stroke on upper independent end-working slides	0—5¼"	0—5¼"
Height of spindle from cross slides	3½"	5·03"
Feed stroke on lower cross slides	0—1¾"	0—1¾"
Feed stroke on upper cross slides	0—2½"	0—2½"
Spindle speed range in 24 steps, r.p.m. ..	51—675	29—473

NO CAMS TO CHANGE

The Wickman patent auto-setting mechanism effects alterations to tool feed strokes and bar feed without cam changing.

Write to-day for this new Catalogue

COVENTRY

COVENTRY, ENGLAND. *Telephone: Tile Hill 66271*

Wickman

337 wm

The **Plessey**

unique design

HYDRAULIC PUMP

is so universally adaptable

Adaptability is the secret behind the success of the Plessey range of Hydraulic Pumps. Their easy installation, compact design and extra high level performance are reasons why they make a strong appeal to design engineers whenever hydraulically operated equipment is being considered. Moreover, designers have discovered that a pump for any particular purpose can be selected from the standard range, thus obviating special tooling. There is a suitable pump in this range to meet most normal requirements.

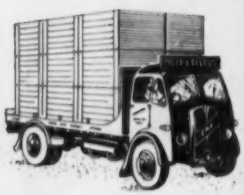
TRACTORS OF ALL TYPES

Many tractors of British manufacture incorporate the Plessey Hydraulic Pump for the operation of the power lift. The example illustrated is the "Massey Harris" 744D Tractor.

HEAVY LIFT TRUCKS

Note how easily the Plessey Pump has been introduced into the design of "Stacatruc" fork lift trucks. The Pump is here directly coupled to the motor unit.

In all situations where maximum use must be made of restricted space, the Plessey Hydraulic Pump is a most flexible and undemanding component.



HEAVY TRANSPORT BRAKING

Here again, the adaptability of the pump is much in evidence. Mounted directly on the gear box of this E.R.F. Lorry it forms the heart of the hydraulic system giving pressure servo assistance for efficient braking under heavy load conditions.

✻ *Write for full information in Publication No. 680*

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COMPLETE UNITS TO CUT COSTS & SPEED ASSEMBLY

SILENTBLOC-HARRIS C.P.

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CONCENTRATED PRESSURE

Patent application 6907/48

Proved in service, the Silentbloc-Harris Concentrated Pressure Spring Shackle is now a standard fitting on a number of popular production cars.

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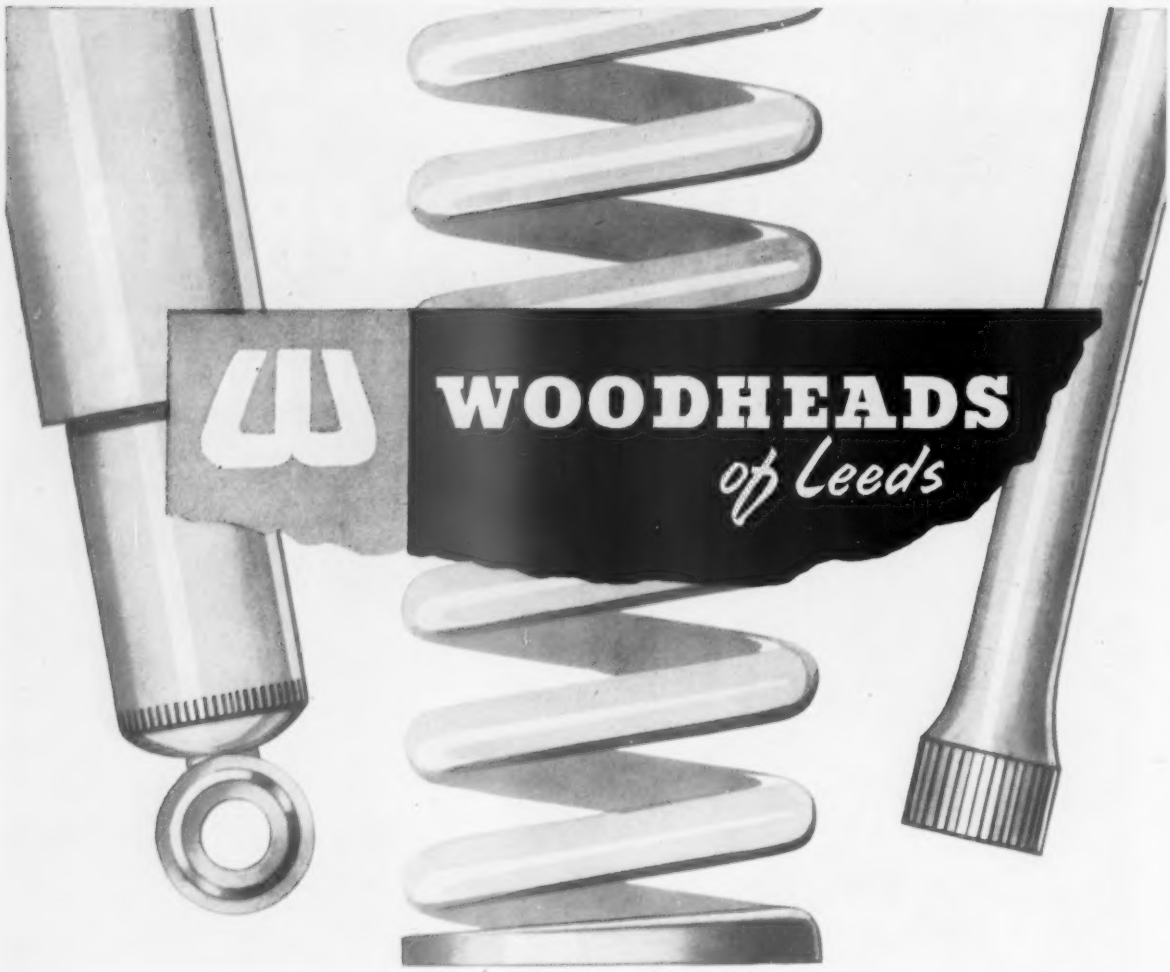

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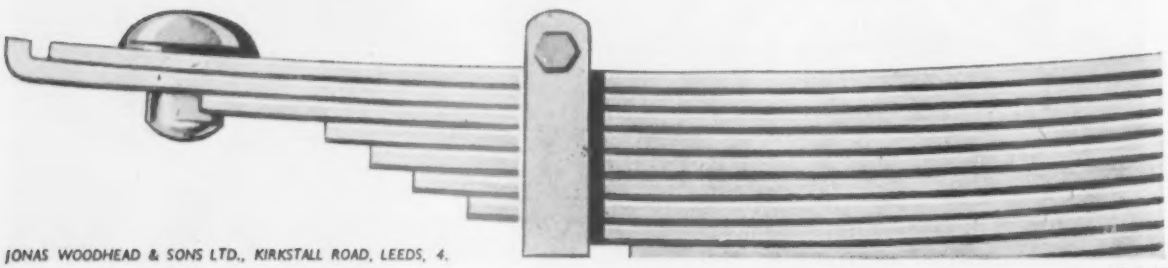

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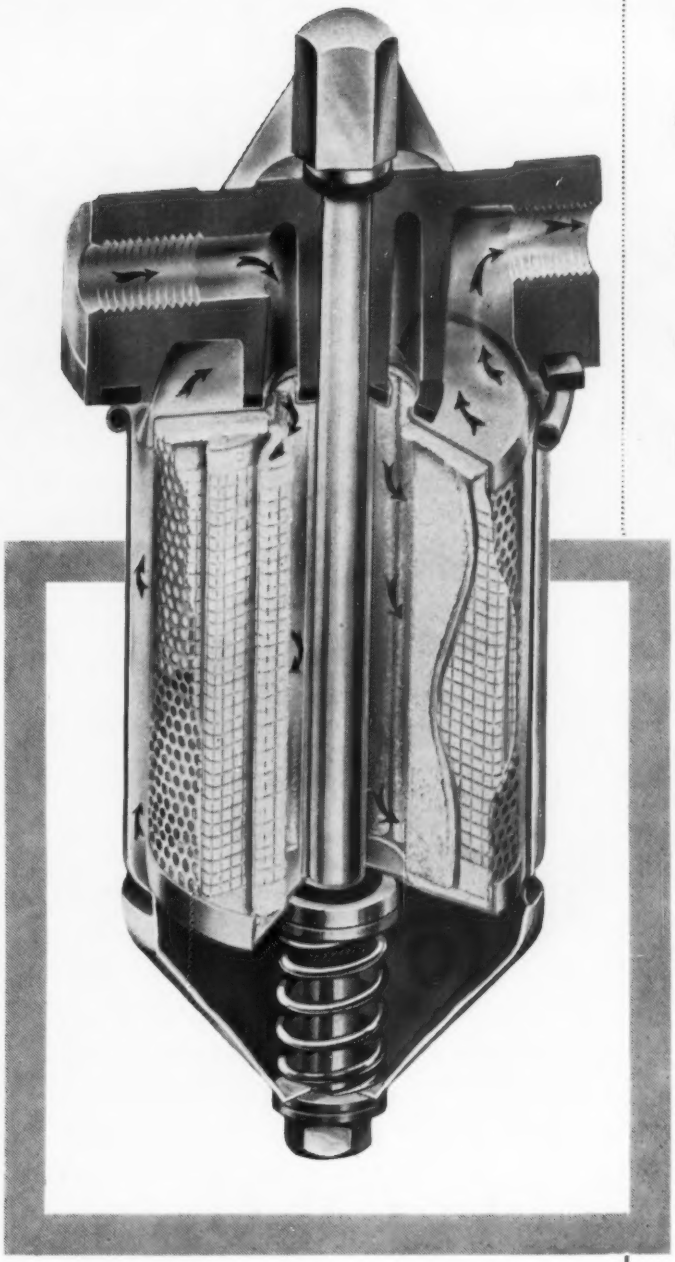

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Only a *full flow filter* can give real engine protection. This fact is today almost universally acknowledged—yet even a so-called full flow filter must match up to the following requirements:—

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The VOKES element filters not only on the surface plane but, to a certain predetermined extent, into the depth of the felt fabric itself. This gives much greater efficiency in arresting all particles large enough to cause damage or wear and, even more important, ensures a build-up of sludge much slower than would be the case with an element providing surface filtration only.

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The policy of expendable elements may be satisfactory if spares are always available, but what happens if a machine in some remote place is prevented from working because no spares are available? VOKES filter elements can always be cleaned—a feature which ensures economy in the long run.

Non-recirculation of trapped sludge

In the VOKES principle, filtration is from the INSIDE to the OUTSIDE, which means that all the sludge is trapped in the centre of the filter element and cannot in any circumstances be recirculated.

VOKES

pioneers of scientific filtration

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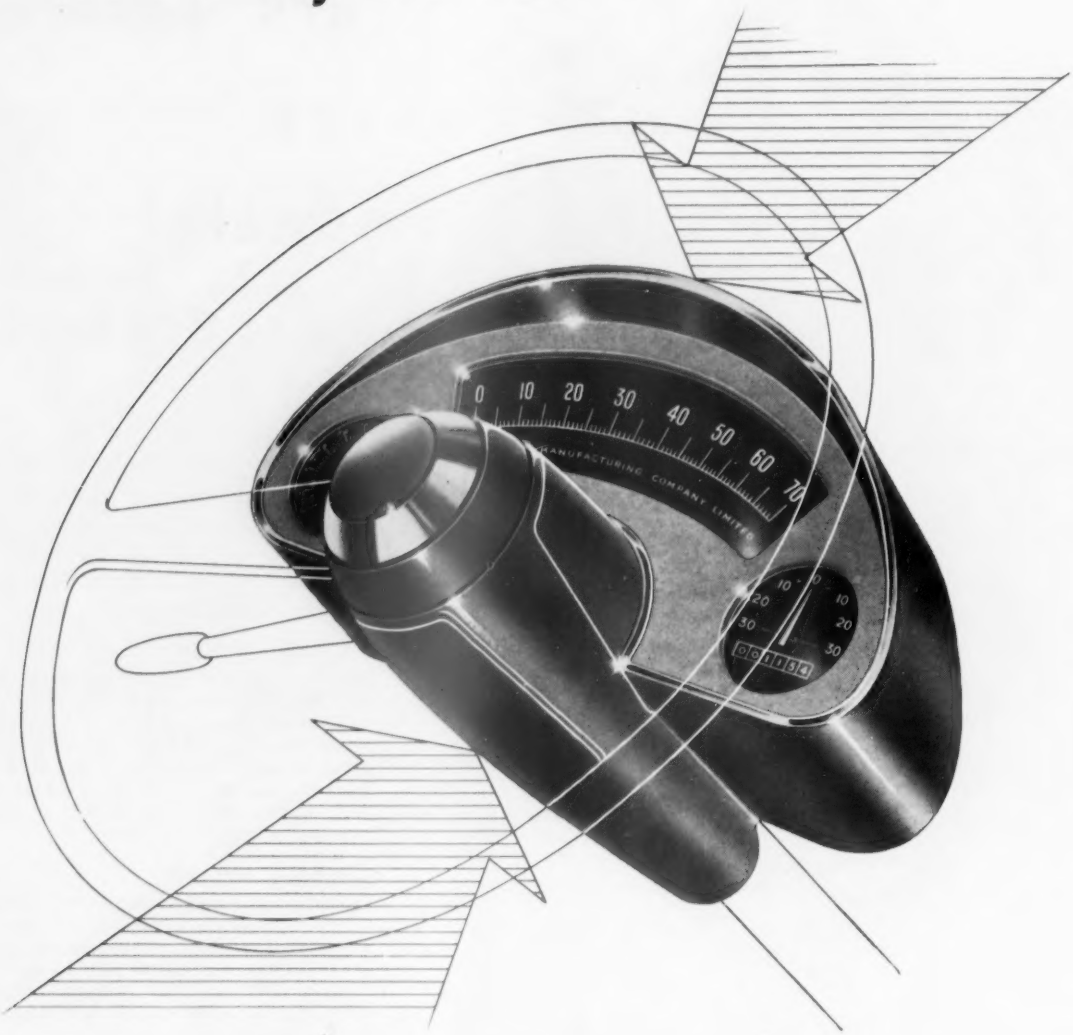
VOKES (Canada) LTD., Toronto *Represented throughout the world* *VOKES AUSTRALIA PTY. LTD., Sydney*

It's easy to see—



it's PRESSURE DIE CAST!

'It's easy to see' is the keynote of modern instrument panels—and the new binnacle type combines easy reading with distinctive styling. Only pressure die casting can give such components the beauty and accuracy of manufacture. Components such as these can be produced quickly in one piece by this method and Mazak is the preferred die casting metal.

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The operational efficiency of any type of mechanical equipment depends on the reliability and successful functioning of the oil seals. With this in mind, Charles Weston and Co. Ltd. have produced during the last 21 years a range of oil seals second to none for efficiency, ease of installation, quality and precision. There is a Weston Seal to suit most mechanisms but we do invite users to let us solve any particular sealing problem arising from speed, temperature, pressure or fluids.

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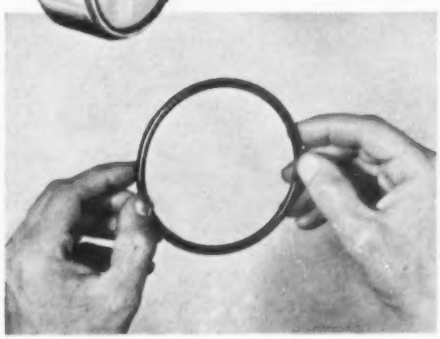

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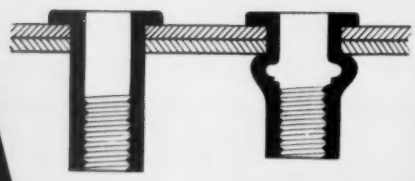
THESE ARE OUR PRODUCTS

No. 6 the rivnut



The sixth and last in this series of advertisements devoted to our products, the very essence of the Rivnut is its versatility. You can fasten ***with*** it and ***to*** it—or do ***both*** at once. You can use it as a blind rivet or nut plate, or both. Strong, light and really simple to use, the Rivnut can be upset with a simple tool entirely from one side of the work, and is threaded internally to provide an additional firm anchorage to which further attachments may be made.

This series of advertisements may serve to give some brief indication of the scope of our organisation, and our range of products. And everything we make reflects the experience of over a quarter of a century devoted to achieving the highest standards of quality and service.

Linread

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COVENTRY MOTOR FITTINGS

CMF

Radiator Production Specialists

50 years experience of cooling design problems and quantity radiator production. Our Design Dept. is able at any time to put forward a suitable type of radiator or allied equipment for your special requirements.

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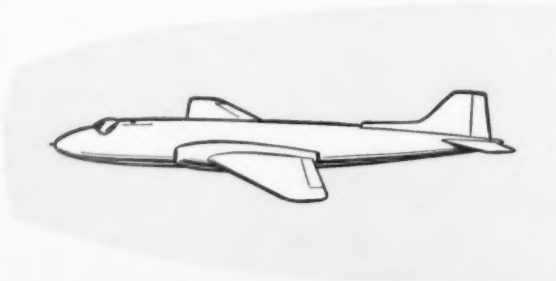
Incorporating the C.M.F. FLAT TUBE BLOCK

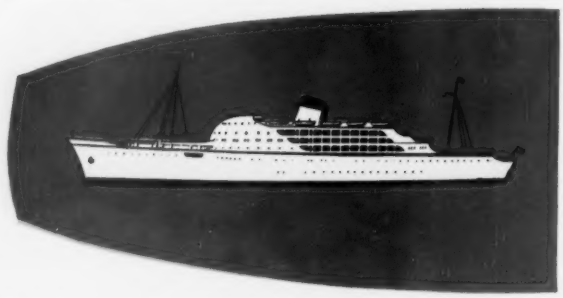
Cogent

Improved principles of **FUEL BURNING . . .**

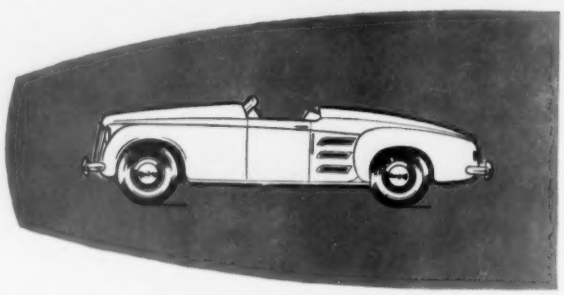
the contribution of Lucas research



LUCAS holds an unequalled position in the field of fuel-burning. No other company has so much experience or such facilities for the development and production of fuel-burning equipment. By continuous research and the application of improved principles, Lucas has made notable contributions to all industries using motive power . . .

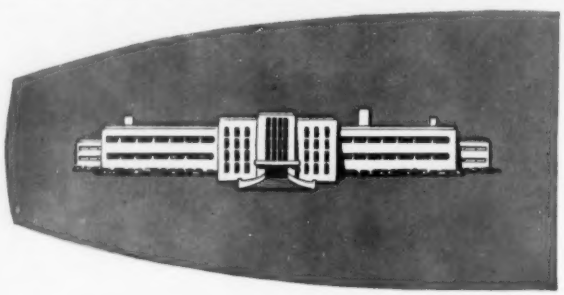


Lucas gas turbine equipment is fitted to the majority of British aircraft, including the Comet, Viscount and Britannia. The Olympus engines of the Canberra which attained the altitude record of 63,668 ft. were also equipped with Lucas components.



- Lucas fuel-burning equipment is on continuous ocean service in a number of modern ships.

- Lucas equipment is installed in the engine of the revolutionary new gas-turbine car—first of its type in the world—made by the Rover Co. Ltd.



- Lucas equipment is incorporated in the gas turbine engines used to power generating plant in large marine and industrial installations.

For all fuel-burning problems, consult the Gas Turbine Equipment Company . . .

LUCAS

FUEL AND COMBUSTION SYSTEMS FOR GAS TURBINE ENGINES

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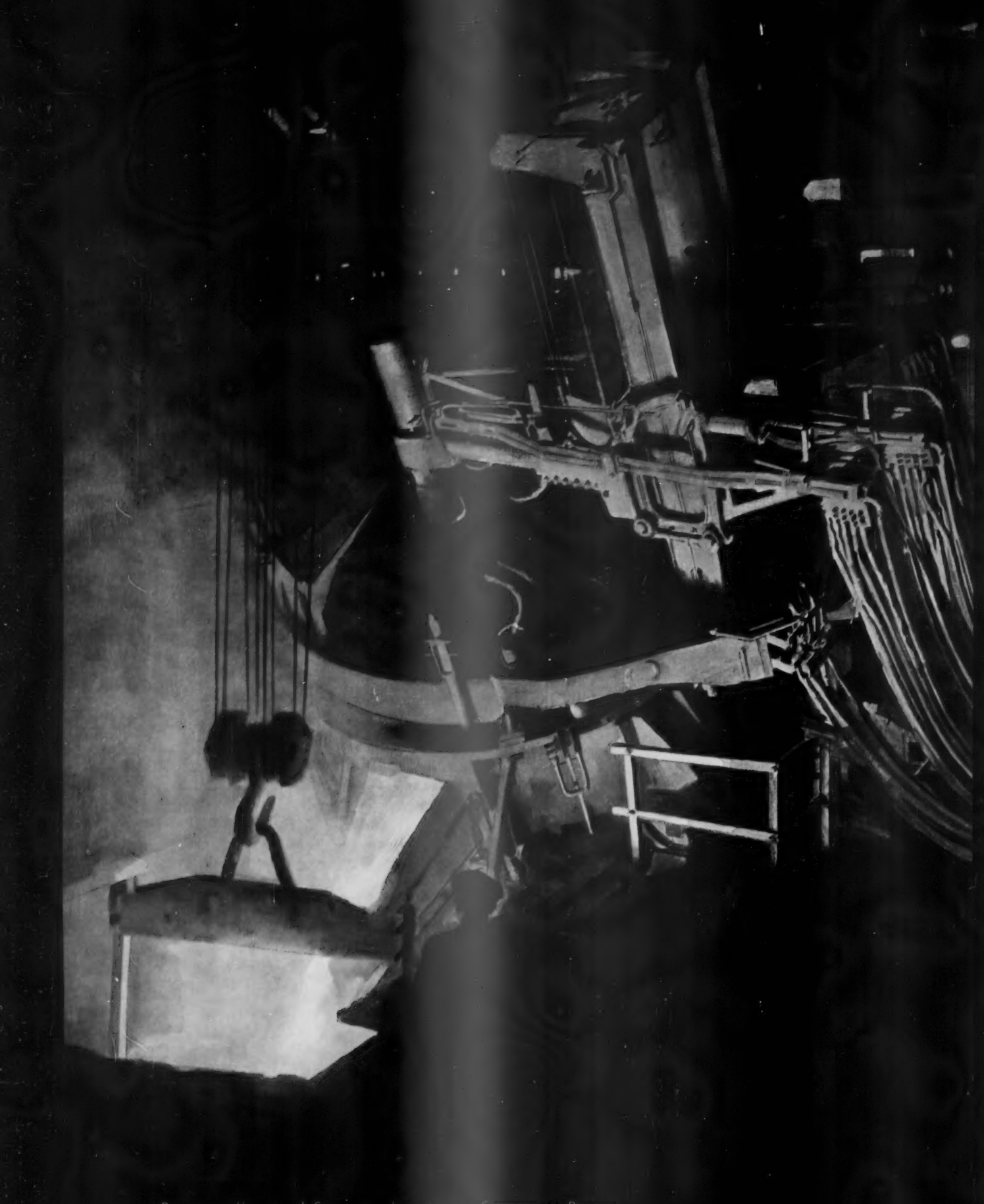

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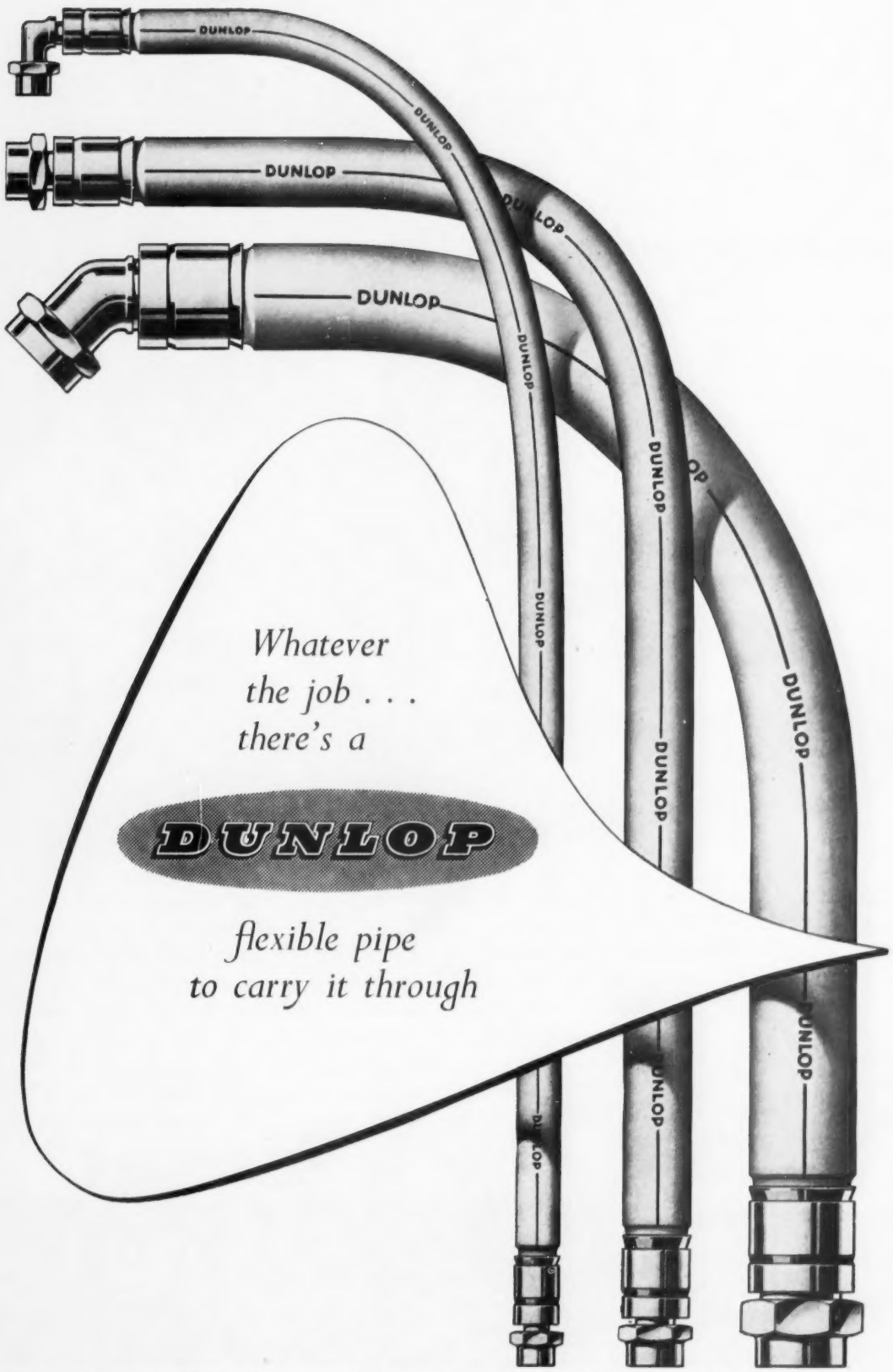

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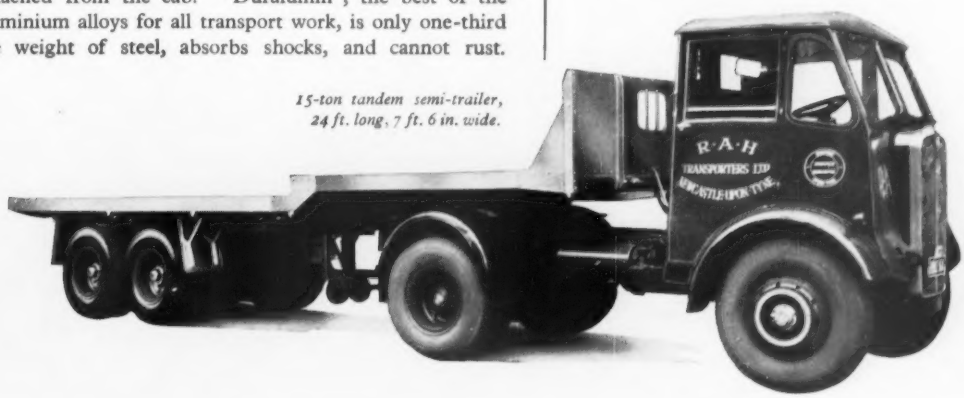

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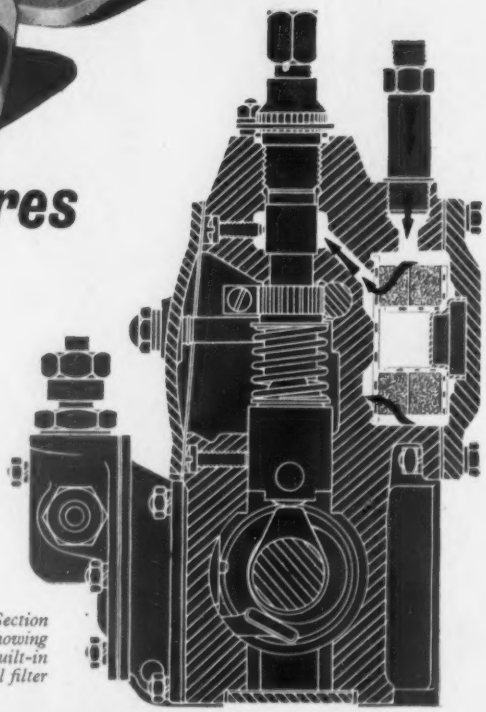

Section showing built-in final filter

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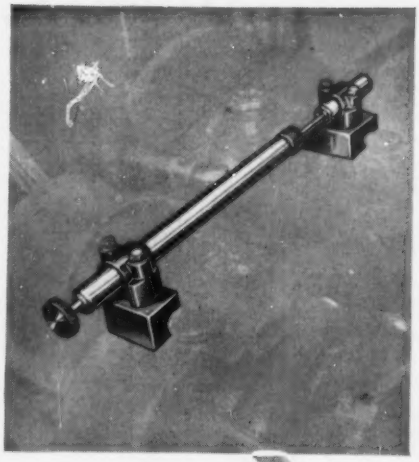

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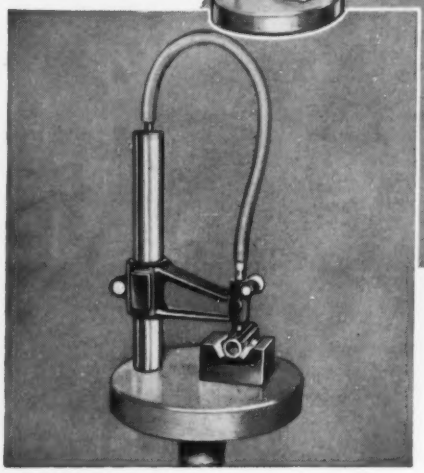

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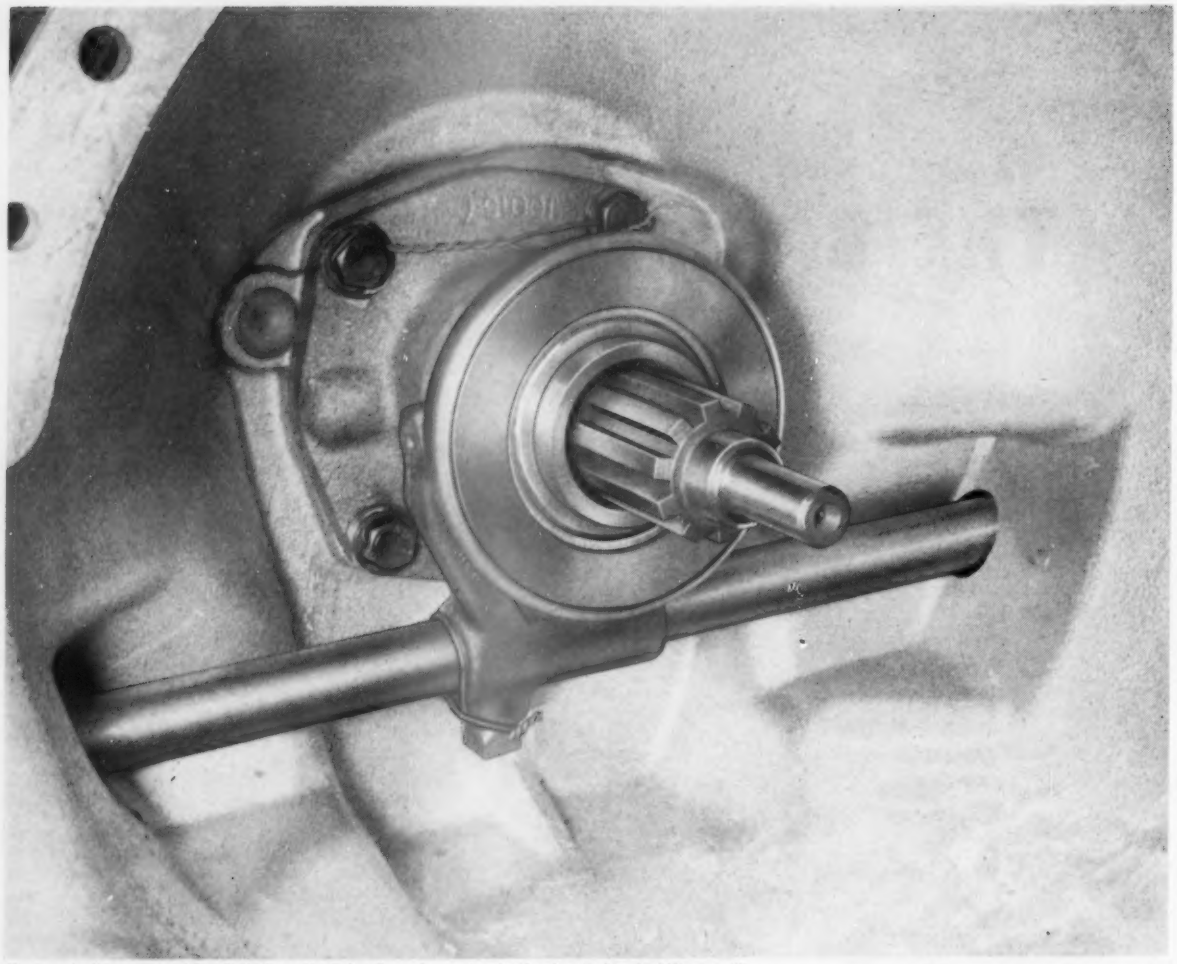
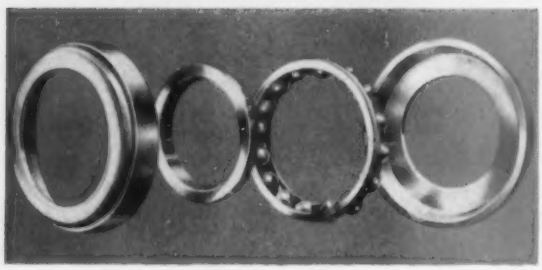


Photograph—by courtesy of Standard Motor Co. Ltd.—shows the new bearing fitted to the Standard 'Vanguard.'

15 times the normal life of a clutch withdrawal bearing



The new Pollard clutch withdrawal bearing, a completely sealed unit, has been tested by independent motor car manufacturers to the extent of 15 times the normal life of alternative bearings for this application - WITHOUT A FAILURE. When stripped, the bearing was found fit for further service without the need for a new lubricant or other maintenance. An exploded view is shown on the left. Full details may be obtained on application to the Technical Department.

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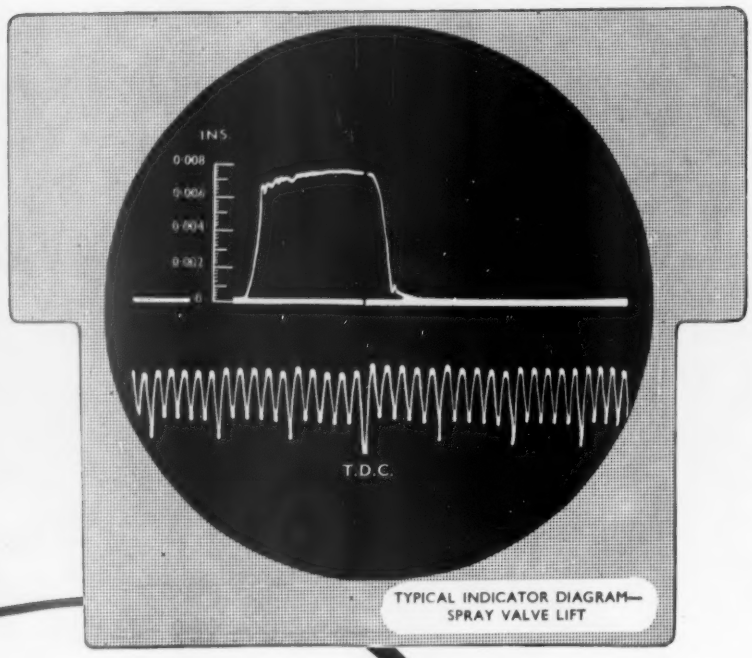
STANDARD-SUNBURY electronic engine indicator

for



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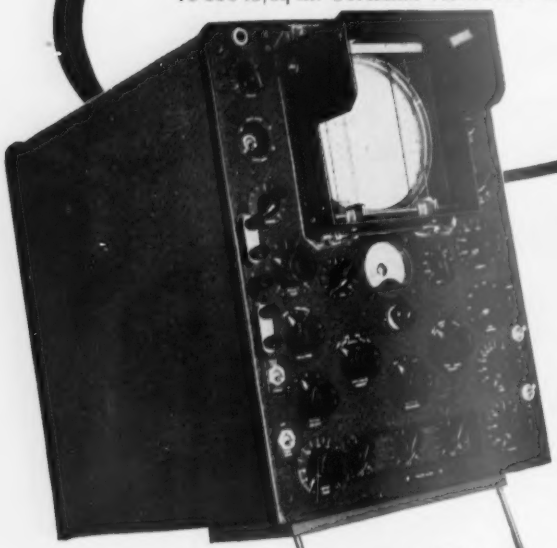

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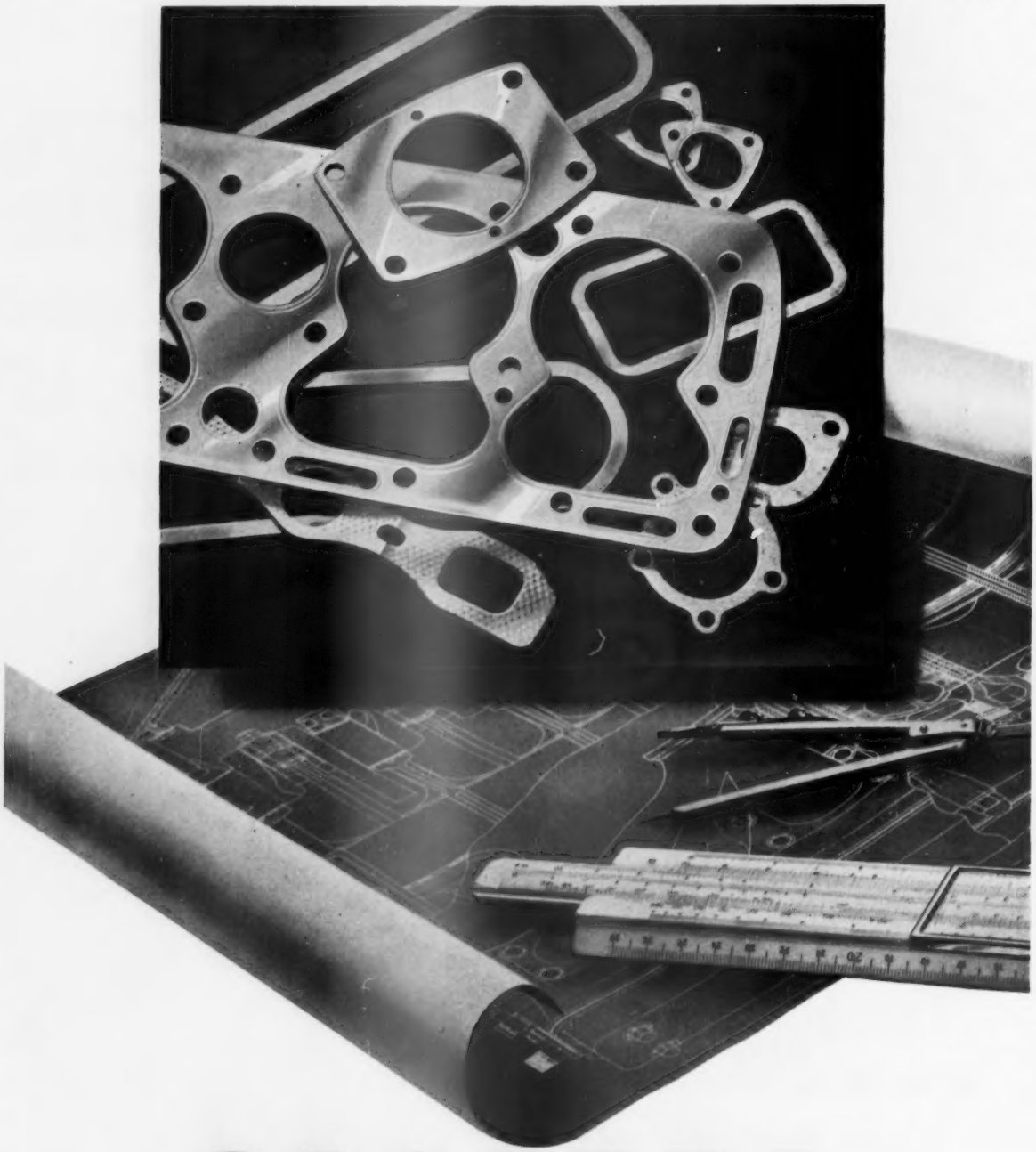

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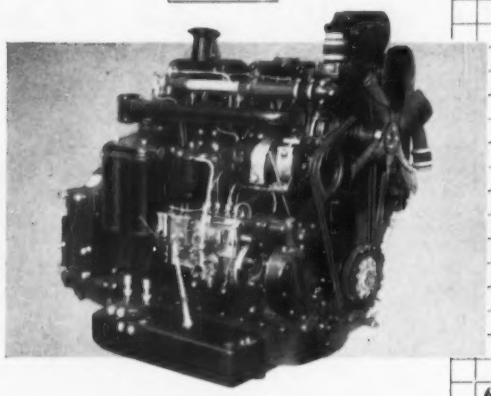
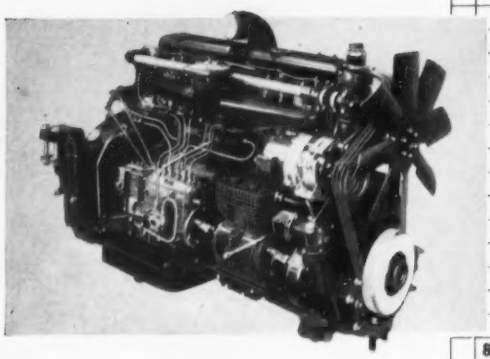
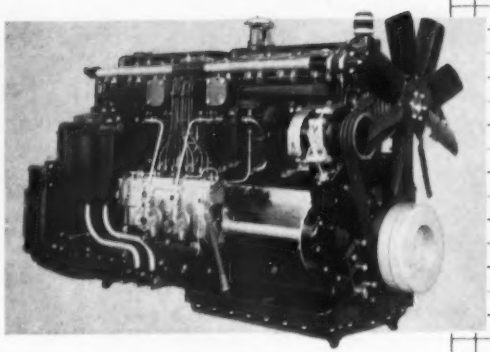
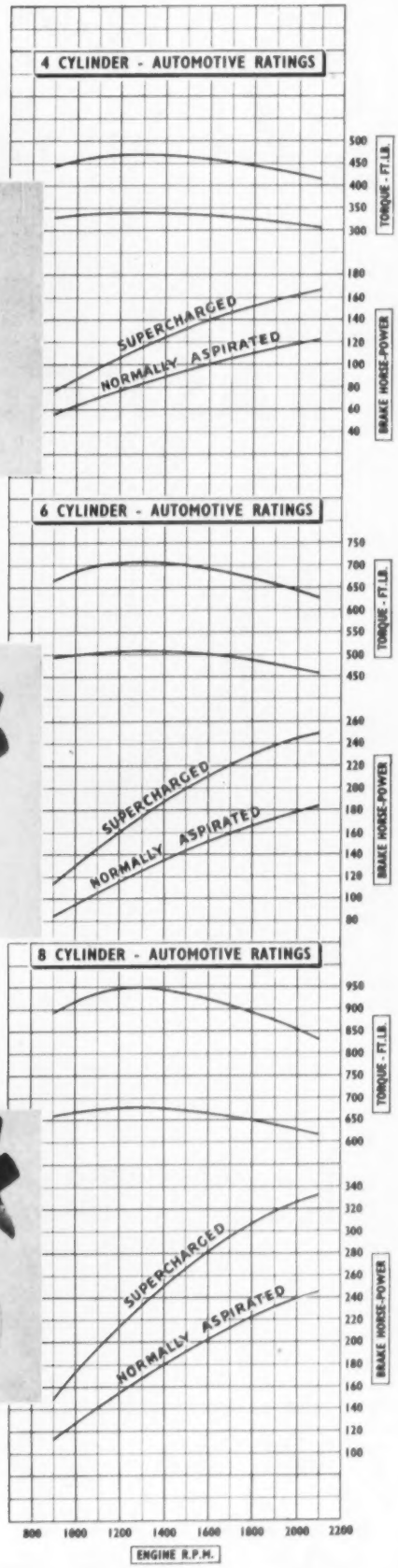






. . . designed for the user who wishes to take advantage of a series of engines with common spare parts. Features of these engines are high power/bulk ratio and interchangeability with units of comparable overall size.

Rolls-Royce oil engines are already being used in crawler tractors, scrapers, dumpers, trucks, generator sets, boats, compressor sets and oilfield equipment.



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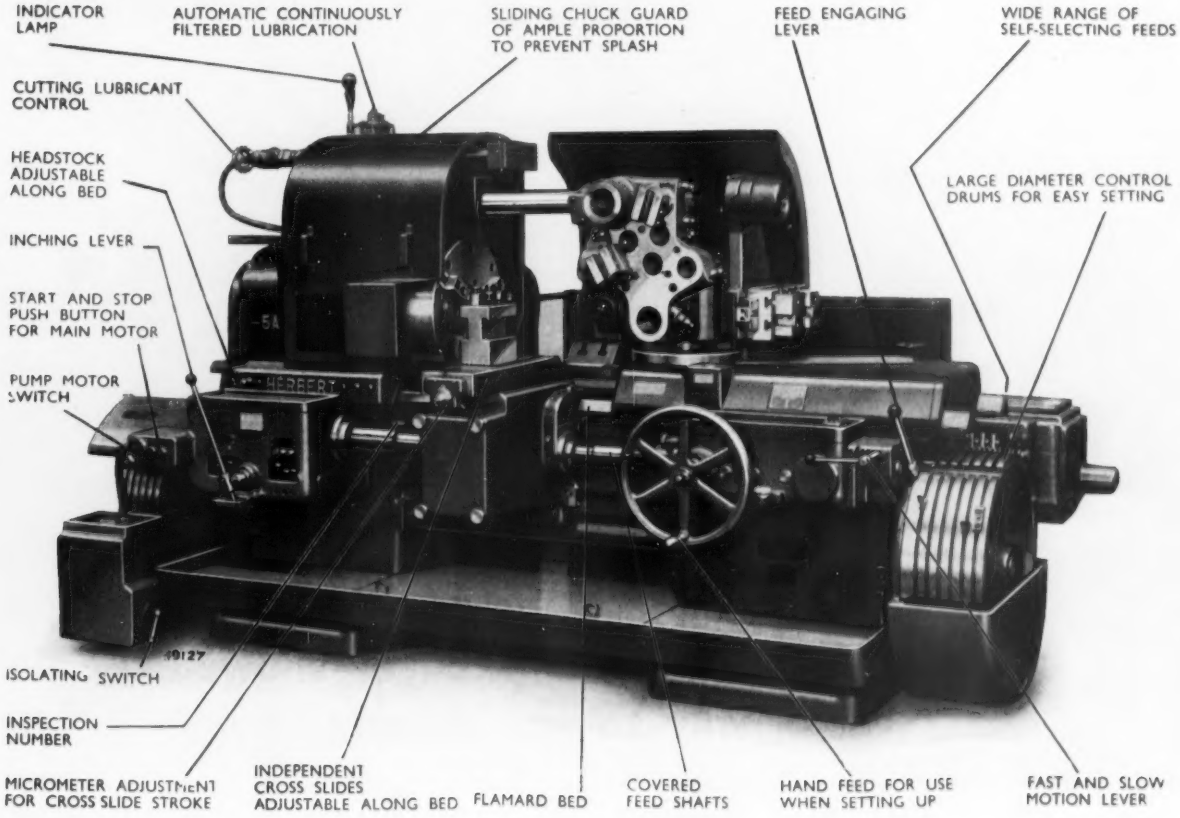
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Feeds are in two groups of seven feeds each. By the self-selecting feed motion any one of the seven feeds in each group can be obtained automatically, changing under cut if desired.

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EARLY DELIVERY

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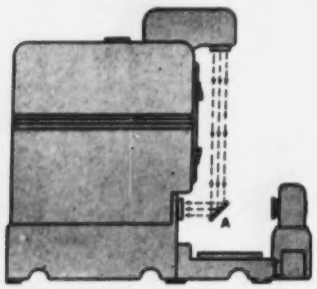
ALFRED HERBERT LTD · COVENTRY

Plain Pointers on Projection

AMONG the definitions listed by Webster for the adjective *universal* is: "adapted or adaptable to all or to various uses, sizes, shapes, et cetera"—a definition we like to feel applies to Kodak Contour Projectors.

Admittedly, we make two projectors, one for routine inspection gauging (the low cost of which might surprise you) and a second for toolroom use affording measurements to "tenths". Optically, however, these two instruments are one. And it's their optical system which makes them truly "universal".

Back in the early days of design, our engineers set out to provide in a single contour projector light sources both for horizontal and for vertical shadow projection. They also developed the unique Kodak Surface Illuminator, a self-contained light source which affords surface projection in either plane. Their reasoning was economic. By combining these features, the instrument could be easily adapted to a wide range of parts; the more uses to which the projector might be put, the sooner it would pay for itself in the shop.

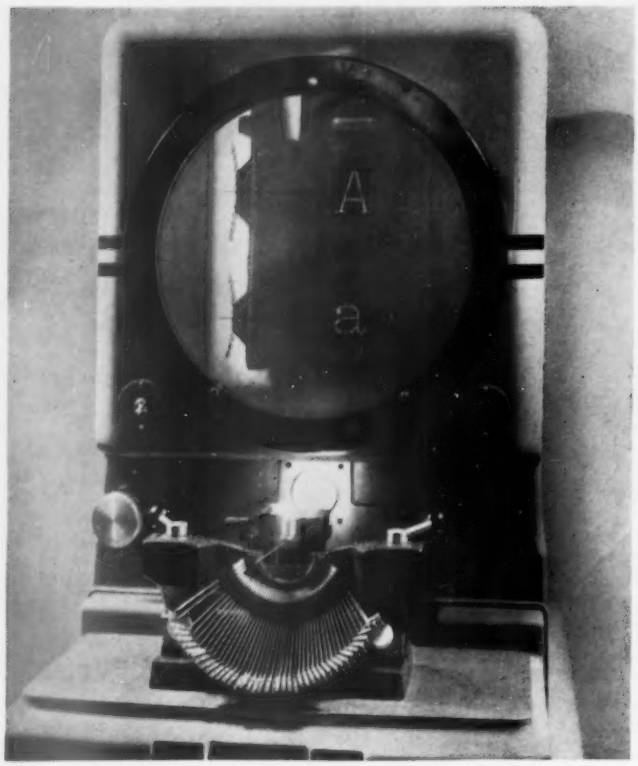


Above drawing illustrates how vertical light source is utilized. With part on a glass staging platform, image is reflected by mirror (A) into optical system of projector.

Nothing has happened since the design stage to shake us in this belief. However, we have been somewhat surprised by some of the highly ingenious ways in which our projectors are used: as in the case of the typewriter fixture (illustrated in our advertisement at the right), where the surface illuminator yields a simultaneous plan and profile view of the type bar face.

Equally ingenious, if not more so, is a device which employs both the horizontal and vertical light beams to simultaneously project the shadow image of a shaft and a reticle scale for gauging its tolerances. A description of this application, which runs to more words than space here affords, is available on request from Gaston E. Marbaix Ltd., Devonshire House, Vicarage Crescent, Battersea, London, S.W.11. Just ask for the folder on the new, universal shaft checking fixture.

Applications such as these have opened the eyes of many engineers to the fact that inspection by optics today has overcome traditional limitations. In the best sense of Webster, contour projection may be "adapted to various uses, sizes, shapes, et cetera". And to the solution of various problems in inspection and precision measurement, including, perhaps, your own.

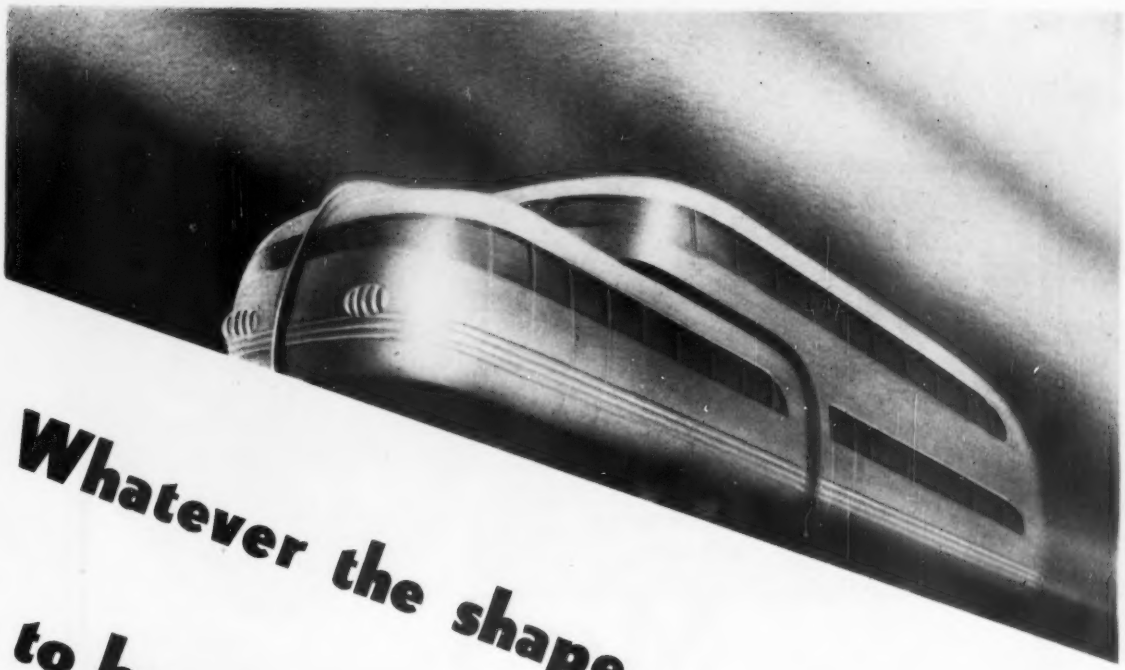


This "3-D picture" showed the way to cut aligning time 25%

What you see here on the Kodak Contour Projector is both the *front* and *side* view of a typewriter type bar—a picture that helped reduce aligning time 25 per cent. at Commercial Controls Corp., manufacturers of tape-controlled Flexowriters and Justowriters. Light reflected from the surface of the type character provides an image for rapidly checking horizontal and vertical alignment of the letter. Simultaneously mirrors in the special holding fixture project a profile image of the type—yield an accurate check of the desired position of the letter as it will contact the platen. Only the Kodak Contour Projector's unique surface illuminator makes possible this combined plan and profile view. Alignment of type is a critical factor on these automatic machines which type at 100 words a minute and must produce copy for printing reproduction. Until recently, Commercial Controls had to perform this inspection operation during final assembly. Now, this new gauging technique has made it possible to inspect the type bars immediately after their removal from the soldering jigs. Each bar is quickly moved into place and compared with the tolerance lines of the chart-gauge on the screen. Alignment of letters is held to a tolerance of ±.0002 inch, contact to ±.0015 inch. And, by catching errors at this point, aligning time has been cut 25 per cent. Perhaps the speed, precision, and economy of optical gauging can help you solve a difficult inspection or measurement problem. Our representative will be glad to call and discuss your problem with you. You can get in touch with him or obtain a copy of the booklet, "The Kodak Contour Projector", by writing to:

GASTON E. MARBAIX LTD

DEVONSHIRE HOUSE - VICARAGE CRESCENT - BATTERSEA - LONDON - S.W.11



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OUR ENGINEERING DEPARTMENT WILL WELCOME THE OPPORTUNITY TO CONSIDER YOUR SPECIFIC APPLICATIONS AND MAKE RECOMMENDATIONS.

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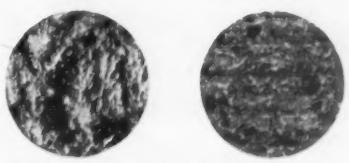

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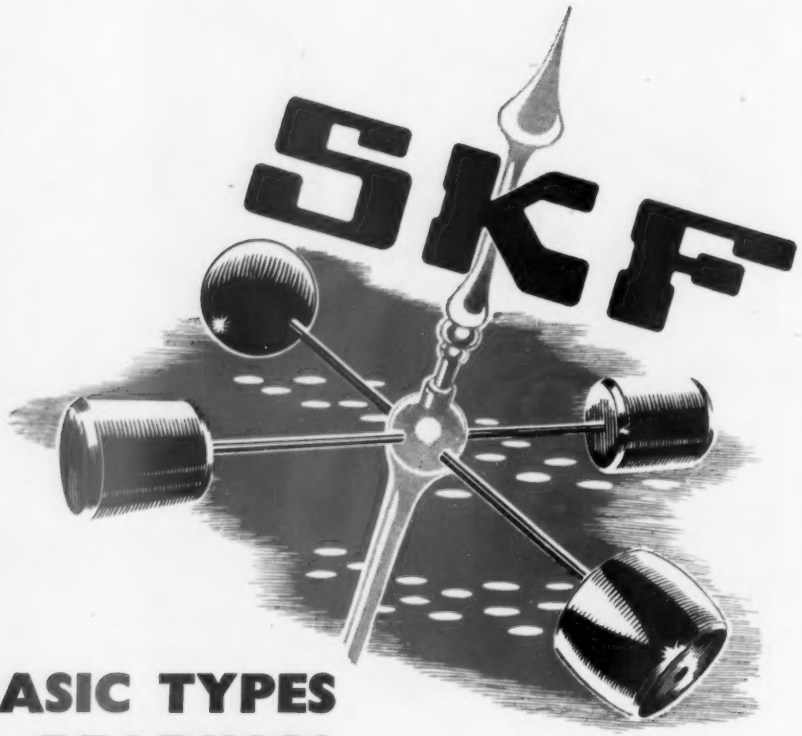

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Body Styling

ALTHOUGH tastes in body styling differ widely, as between both individuals and peoples, there is throughout the world considerable agreement on the fundamentals of the subject. This is shown by the fact that positive trends are discernible in all the international motor shows. It is mainly on detail interpretation of the fundamental principles that ideas differ from one country to another. For instance, the open-mouth type of radiator grille has been adopted in all countries, but whereas the Americans surround it with masses of chromium plate, the British seem to prefer a plainer form and the Latins tend to adorn it with light ornamentation.

To harmonize this type of front end with the overall conception common to most modern vehicle designs is not easy. The frequently adopted practice of framing the opening with chromium plate accentuates the lines that clash with the remainder of the body contours. On the other hand, some additional treatment is necessary both to break up the plain and ugly appearance and to blend the feature in with the remainder of the style.

Many methods have been tried; they include the incorporation of a multiplicity of vertical bars, horizontal bars, diamond lattices and square mesh grilles, but the most satisfactory seems to be the use of a single horizontal bar with some form of central ornamentation and with or without a frame round the opening. An illustration of a pleasing variant of this theme can be seen in this issue; it is the Pinin Farina Fiat 1100. The central V continues the line of the bonnet lid handle and the duct on the crown of the bonnet lid, while the horizontal bar on each side blends with the arrangement of the lamps and horizontal rubbing strip on the sides of the body. At the same time, the soft outline of the opening harmonizes well with the outline of the vehicle.

Overall conception

From recent developments with slab sides, imitation wing forms pressed in rear quarter panels and ornamentation with chromium plated strip, there has arisen a reasonable degree of agreement as to what is the best from all points of view. For this reason, there were no departures from what is now regarded as conventional to be seen at the 1954 Geneva Show, except among the sports cars. Rockets and guided missiles are generally associated with enormous speeds, and so there is a tendency for specialist coachbuilders to produce bodies styled on this theme, presumably to appeal to youthful imaginations. Jet-type air intakes are common on this type of vehicle.

Among the European family cars, design features that have practical value as well as aesthetic appeal have become well established; whereas those that are purely ornamental, especially when they are undesirable from the functional point of view, have been abandoned. The features that have become generally accepted include the open type of radiator grille already mentioned, which in no way restricts the air flow to the radiator, and upstanding rear wing crowns which, because of their influence on the aerodynamic behaviour of the vehicle, give better handling characteristics. Exceptionally good all-round visibility is associated with the hard-top form of canopy, which is in great demand, particularly in America. On the other hand, the binnacle type of instrument on the steering column has fallen out of favour because it is too close to the driver, and the re-focusing of the eyes from the distant view through the windscreen, to the dial and back again is more difficult than when the instrument is in the more remote position on the dash.

Some American developments are completely pointless. For example, imitation wire spokes are sometimes fitted to disc type wheels. In addition, chromium plated strips are used externally for ornamentation above the waist rail. This in some instances tends to make the style appear top-heavy; moreover, after a few years, when the plating has deteriorated, these cars will look shabby.

The future

While it would be rash to forecast the future course of events, it is not so difficult to make suggestions as to what steps ought to be taken to improve the product. Manufacturers the world over have still a long way to go in improving all-round visibility, particularly in reducing the cross sectional dimensions of the windscreen pillars. That windscreen pillars are not necessarily essential structural components is shown by the fact that convertible bodies are a practical proposition. Admittedly, the structural stability of this type of vehicle is not always as good as might be desired, but some are satisfactory and there seems to be no reason why all could not be so. Moreover, on the new models incorporating the wrapped-round windscreens, the pillars above and below the waist are a long way out of line, and therefore cannot add much to the strength of the vehicle.

Progress still remains to be made in the direction of

improving detail fittings. For instance, bumper ends are usually extended a short distance round the sides of the vehicle. These should be designed in such a way that they cannot act as hooks and catch objects that the vehicle is passing. It has been known for garage doors to be taken inside on the rear bumper as the car has been put away for the night. Even more important, bumpers should always be bumpers and not merely embellishments.

Door sealing

Sealing strips round the doors of saloon cars are usually of sponge rubber. Although very soft material is used, a relatively long length of it has to be compressed before the door will shut, and it offers an appreciable resistance to closure. This resistance is not easily overcome by ladies. A number of manufacturers are now using channel-section rubbers, with one arm of the section stuck to the door and the other bearing on the pillar, or *vice versa*. Not only is this section more flexible than a solid one, but it tends to be self sealing when the pressure of the air locally is greater on the outside of the vehicle. Furthermore, it can be designed to have a larger deflection at a constant rate than a solid one.

Seat squabs hinged at their base are becoming increasingly popular abroad, even on small family saloons. With this arrangement not only is it relatively easy to provide for the adjustment of the squab angle, but also the one seat is common to two- and four-door versions of the same model. So far as accommodation for maps, parcels, handbags and other small articles is concerned, British cars generally are far superior to either European or American ones. Doubtless, foreign manufacturers will soon follow us in that respect.

It is neither arrogant nor insular to claim that in general British practice can bear comparison with that of other countries. At the same time it must be admitted that the British automobile industry must be prepared to learn from any developments that foreign competitors may make. There is no doubt that this is being done and will continue to be done.

The Critics Confounded

In the course of the recent Geneva Show it became evident that the strictures passed by the industrial experts of the United Nations Organization on the British automobile industry, which were the subject of comment in these columns in the March issue of this journal, have received considerable credence on the Continent. At the time the original comment was written it was not possible to make reference to a most telling rejoinder to the critics, the Nash 'Metropolitan' with its Austin chassis and Fisher and Ludlow body.

When the Nash Kelvinator Corporation decided to market what is by American standards a small car, they had a choice of alternatives; (a) they could develop and manufacture a completely new vehicle or (b) they could subcontract the manufacture to some organization already producing a car of substantially the required size and performance. The first alternative would have entailed considerable development work and an outlay in the order of at least £1,000,000 for tooling. Obviously the second alternative was the more attractive if a suitable vehicle could be obtained at a competitive price.

There were four possible sources of supply, Great Britain, France, Italy and Western Germany. The dollar earning possibilities of the proposition were such as to arouse the interest not only of individual organizations but also of the various Continental governments, who are all ready to adopt special fiscal practices to assist manufacturers to earn dollars. British industry had to rely on merit alone.

The Nash Kelvinator Corporation had no reason to favour any one country or company. For them, it was purely a commercial transaction, and their sole interest was to obtain at a competitive price a chassis of proved worth carrying a body of distinctively American style. Therefore, the decision made is in effect an impartial judgment both on chassis design and manufacturing efficiency. That the contract for manufacture was finally placed with the Austin Motor Co. Ltd. is a sufficient answer to the strictures of the 'industrial experts' of U.N.O.

CONTENTS

	Page
Editorials — Body Styling. The Critics Confounded	129-130
The Geneva Show — Bodies and other Features of Interest in Private Continental Cars	131-136
Cornering Characteristics of Tyres. By V. E. Gough — An Improved Method for their Determination	137-141
Chucking Automatics — Two New Wickman Machines	142
Continental Coachwork — Some of the Custom-Built Bodies at the Geneva Show	143-146
Minicars — Three Continental Models	147-149
Nickel-Chrome Plating — An Outstanding Plant at the Works of Vauxhall Motors Ltd.	150-153
Swarf Recovery — A Hydraulic Baling Press for Briquetting Cast Iron Machinings	154
Buses and Coaches — Recent Continental Developments	155-158
Headlight Setting. By V. J. Jehu, M.Sc., A.Inst.P. — Part I.—An Investigation of Commercial Testers	159-164
American Bodywork — Features of Some of the 1954 Models	165-168
New Plant and Tools — Recent Developments in Production Equipment	169-171
Rear Suspension — An Experimental Independent Rear Suspension System	172
Akulon — A Nylon-type Material that may have Many Applications in Engineering	173-174
Goods Vehicle Cabs — Higher Standards of Comfort, Appearance and Efficiency	175-176
Current Patents — A Review of Recent Automobile Specifications	177-178

THE GENEVA SHOW

Bodies and other Features of Interest in Private Continental Cars

THE Geneva Show is of importance to exhibitors not only because the country has common frontiers with France, Germany and Italy, but also because the city is a centre in which a number of international conferences are held and in which there are many international organizations. It is, therefore, an exhibition that is visited by representatives of most of the countries of the world as well as by potential customers in Switzerland. Furthermore, local sales are more than welcome because they bring in hard currency.

From the table on the next page, giving the total imports in 1952 and 1953, it can be seen that although 8,910 more cars were imported into Switzerland last year than in the previous twelve months, the figures for cars shipped from Britain are 5,047 and 4,105 respectively for the two years. This represents a fall in sales of about 18·7 per cent. Even more significant is the fact that this fall has occurred during a period when total imports of cars into Switzerland have increased by about 31·7 per cent and all of the other major motor-manufacturing nations have increased their exports to that country.

However, these figures are only part of the story and as such can be misleading. It is significant, as can be seen from the other table, which gives imports of different manufacturers, that of the large increase of German imports to Switzerland, 3,176 are Opel models, 1,120 of which were assembled in Switzerland, and presumably a large proportion are the new Rekord and possibly the Kapitan vehicles. Moreover, although the Italian exports to this country increased by 1,584, the Fiat concern alone sent 1,596 more vehicles in 1953 than in 1952. In other words, the biggest advances have been made by those manufacturers who have introduced new models in the popular family saloon class. Therefore, it seems likely that with the introduction of new models by British manufacturers sales will again increase.

There is one exception to this trend towards large numbers of cars being sold in Switzerland by the manufacturers who have recently introduced new models. This is the Volkswagen, of which 2,948 additional vehicles were sold in 1953 as compared with 1952. The low price of this vehicle makes it attractive to the Swiss; moreover, it can be left out in the open all night in sub-zero temperature conditions without ill effects.

In some quarters, it is said that anti-freeze mixtures cause corrosion in cooling systems, and are not satisfactory at exceptionally low temperatures. However, this is fallacious; water-cooled engines need not be inferior to air-cooled ones under these conditions. There are anti-freeze mixtures that can be left in water cooling systems all the year round, and at the lowest of temperatures, without harmful effects of any kind. Moreover, if the engine is equipped with accessible and easily operated drain cocks, it is even better to drain the liquid out, store it in a warm place overnight and simply pour it back again in the morning. In these circumstances, water-cooled engines are far superior to the air-cooled units from the point of view of cold starting.

In general, price is the most critical factor in Switzerland. This is demonstrated by the fact that the Volkswagen which, with its air-cooled engine, is noisy by comparison with vehicles of more conventional layout, is selling so well. It also emphasizes the fact that now a buyers' market exists throughout the world, the maintenance of low prices or better still, a reduction of existing ones, is essential.

IMPORTS OF SOME OF THE DIFFERENT MANUFACTURERS

	1952	1953
GERMANY:		
Ford	1,198	2,085
Mercedes	902	717
Opel	2,627	4,683
Opel, Switzerland	—	1,120
Volkswagen	6,349	9,297
Total of all German makes	11,732	19,081
UNITED STATES:		
Chevrolet, Switzerland	1,229	1,379
Plymouth, Switzerland	—	1,123
Total of all American makes	4,889	5,241
FRANCE:		
Citroen	945	952
Ford	25	135
Panhard	26	75
Peugeot	1,098	1,280
Renault	1,168	1,115
Total of all French makes	3,808	4,358
ITALY:		
Alfa Romeo	122	133
Fiat	2,309	3,905
Lancia	129	99
Total of all Italian makes	2,580	4,164
GREAT BRITAIN:		
Austin	814	514
Ford	1,252	796
Hillman	364	363
Morris	393	523
Standard	175	62
Standard, Switzerland	—	50
Vauxhall	53	22
Vauxhall, Switzerland	1,039	986
Total of all British makes	5,047	4,105

Fiat

The Fiat 1100, four-door, four-light saloon model was introduced for the first time at last year's Geneva Show, and the chassis was described in the April 1953 issue of *Automobile Engineer*. This year another version has been introduced; it is the Familiale, which is based on the same chassis and has an identical front end and front doors. However, the back end and rear doors have been changed to form a six-light body of the station wagon type, with an additional door at the back.

This vehicle is powered by a four-cylinder engine with a bore and stroke of 68 mm by 75 mm and a swept volume of 1,089 cm^3. The compression ratio is 6·7:1, and it develops 35·5 b.h.p. at 4,400 r.p.m. A conventional transmission system is employed. The gearbox has four forward speeds and one reverse, and the drive is transmitted by an open propeller shaft to a hypoid bevel rear axle. The overall ratios are: top 4·3:1, third 6·75:1, second 10·2:1, first 16·6:1. On the Familiale version, 560 × 14 tyres are fitted instead of 520 × 14 as on the saloon version. The dry weight of the new model is 1,875 lb.

A bench type rear seat is fitted, and the squab can be hinged down on to the cushion so that its back face is at the same level as the rear floor, to provide a large flat surface for luggage. Two occasional seats are installed in such a way that their squabs can be folded on to their cushions which are then hinged forwards and stowed in wells in the rear floor immediately behind the squab of the rear seat. The whole of the luggage compartment floor, the under sides of the occasional seat pans and the back of the rear seat are covered with rubber sheeting. When the front two seats only are in use, and the rear seats folded down, the luggage platform is 53 in long by 43 in wide.

Separate front seats are employed; their squabs are hinged so that they may be moved forward to improve access to the rear seats, to provide for adjustment of the squab angle, and to allow more room for luggage on one side when the driver only is in the car. When the squabs are in their normal

upright position, they each rest on the heads of two stop screws which can be adjusted by hand to alter the angle of the squab from the vertical. The fore and aft position of the seats is also adjustable.

Arm-rests are fitted on the rear doors and they serve also as pull-to handles. Pockets are provided on the forward half of the front doors; full width pockets are not practicable because the seat cushions are fairly close to the rear halves of the front doors. Simple pressed steel pull-to handles are spot welded to the waist rails of these doors.

Many Continental manufacturers use exceptionally flexible sealing strips round the doors. Two such seals are employed round each door of the Fiat 1100. One is a simple channel section, machine sewn on to a flexible metal channel. This channel is flexible by virtue of the fact that its side walls are segmented. It is fitted over the flanges round the door opening. During assembly, simple U-section steel clips are fitted at intervals of about 4 in over the flanges. One arm of each clip has a tongue extension which is joggled inwards to pass through a slot in the flange. The ends of the segments of the channel that carries the rubber are turned inwards through 180 deg, and when the channel is assembled on to the flange round the door, the tongues of the clips register in the hooks formed by these 180 deg bends and thus retain the assembly in position. The ends of the seal abut over the sill and are concealed by a metal cover fitted over the upper flange of the sill to protect it from damage that might otherwise be caused by the feet of passengers entering and leaving the car.

The outer seal is stuck to the flange round the door. It is also of channel section but the arm that is stuck to the door is hollow. When the door is closed, the free arms of the two channel section seals bear against the adjacent faces of the panelling. Since they are relatively free to deflect, they offer but little resistance to the doors closing. This is a noteworthy feature of the vehicle.

An unusual feature of the doors is that the flanges round the edges of the inner and outer panels are turned inwards through 90 deg where they are spot welded together. However, these spot welds are not visible on the outer face. Aluminium garnish strips are fitted round all six side lights as well as round the rear light and windscreen. The doors are hung on exterior hinges.

A glass gusset panel is fitted in the upper rear corner of each front door. It is positioned to the inner side of the drop glass so that if the window is lowered a short distance for ventilation purposes, it tends to prevent air blowing into the car and causing a draught. This arrangement has two main advantages as compared with the usual triangular ventilating panels fitted at the front of the door. One is that it is less expensive and the other is that it in no way obscures the vision.

On the front floor, a three-piece rubber cover is laid over felt. One piece is over the gearbox cover and the

In the new Fiat 1100 Familiale model there is accommodation for four adults in the front and rear, and for two children on occasional seats behind the rear seat squabs

TOTAL IMPORTS IN 1952 AND 1953

	1952	1953
Germany	11,732	19,081
United States	4,889	5,241
France	3,808	4,358
Italy	2,580	4,164
Great Britain	5,047	4,105
Czechoslovakia	39	92
Other Countries	46	10
Totals	28,141	37,051

The rear squab and occasional seats in the Fiat 1100 can be folded down to provide a flat floor of large area for luggage

In the Opel Rekord the rear legs of the front seats have rollers on their ends and run in tracks recessed into the floor

American influence is evident in the front end styling of the Opel Rekord

other two are fitted one on each side of it. The rear floor is furnished with a woven carpet which has a short pile, and underfelt is also used. On the dash facia, two large instruments with hooded bezels are mounted one on each side of the steering column, and four tumbler switches control the head lamps, instrument panel lights, windscreen wiper and heater fan. A three-position switch is fitted on the instrument column to change from head to side lamps and for dipping the head lamp. Another three-position switch, also on the steering column, controls the trafficators.

A fresh air type heater is installed above the toe board. Controls are provided to direct either all the warm air through the demister slots or part of it downwards adjacent to the front passengers' feet. A simple cock is fitted in an accessible position on the top of the engine immediately behind the radiator so that the water supply to the heater can be cut off in summer.

Among the other features of the vehicle is a petrol cap which, when locked, rotates freely without unscrewing. This means that it is impossible to force the lock with a spanner or chain wrench. The rear bumpers are carried on irons in the usual manner, but about 6 in from their ends, additional support is afforded by welded-on top hat section brackets which are bolted to the rear quarter panel. A single clip, secured by a wing nut, holds down the spare wheel, which is housed under the floor at the back. The rear door is hinged at its right-hand vertical edge and its inner panel is cut away locally to clear the spare wheel.

A simple hinge is fitted at each side of the rear seat squab on the Fiat 1100

Opel

A two-door, cabriolet version of the Opel Rekord was introduced for the first time at the Geneva Show. This vehicle is powered by a four-cylinder, overhead valve engine with a bore and stroke of 80 mm and 74 mm respectively and a swept volume of 1,488 cm^3. It has a compression ratio of 6·7 : 1 and develops 51 b.h.p. at 4,400 r.p.m. The maximum torque of 77·4 lb-ft is developed at 2,000 r.p.m.

A conventional transmission system is employed. It comprises a single dry plate clutch, a gearbox with three forward speeds and one reverse, and a hypoid bevel drive unit. The overall gear ratios are: top 3·9 : 1, second 6·55 : 1, first and reverse 13·92 : 1.

The front suspension is of the transverse, double wishbone-link type with coil springs, and at the rear, semi-elliptic springs with a through axle are fitted. Anti-roll bars and telescopic shock absorbers are employed both at the front and at the rear. Lockheed hydraulic brakes are incorporated. The total friction lining area is 109 in^2. A worm and roller steering gear is fitted, and the tyres are 560 × 13. The principal dimensions of the vehicle are: wheelbase 8 ft 2 in; track, front 3 ft 11¼ in, rear 13 ft 11 in; overall width 5 ft 4 in, length 13 ft 11 in, height 4 ft 11 in; ground clearance 6¼ in, turning circle 35 ft, curb weight 1,935 lb.

Inside the car, a small instrument panel is fitted on the dash facia immediately behind the steering wheel. It carries a semi-circular speedometer with a water temperature gauge on the left and a petrol gauge on the right. Above these two gauges are warning lamps to show whether or not the dynamo is charging and the oil pressure adequate. Another warning light, to show that the flashing indicators are in operation, is mounted in a streamlined housing pressed in the top of the

In the Opel Rekord the spare wheel is stowed vertically behind the rear seat squab

The spare wheel, jack and wheel brace are stowed in an accessible position in the Mercedes Benz 220

shroud round the steering column. Thus, all the instruments and warning lamps are in a central position and can be seen easily between the two spokes of the steering wheel.

Below the facia, to the left of the steering column, is an exceptionally small quadrant for the two control levers of the heater system. One operates the water cock and the other is to direct all the air to the demisters or to divert some to the toeboard. To the right of the steering column, below the centre of the facia, a radio is fitted. An ashtray is mounted above the radio.

On the right, opposite the passenger's seat, is a glove box with a lid that is hinged at its lower edge. It is spring loaded towards the open position so that it does not rattle when closed. A single press-button release mechanism is employed, and below, in the centre of the lid, is a clock. When the lid is open, it is retained in the horizontal position so that it may be used as a shelf. The stiffening of this lid is somewhat unusual. Its edges are turned inwards through 180 deg all round and are clamped down on two stiffening pieces, one at each end. These pieces are rectangular, dished steel pressings which, when together with the lid panel, form box sections.

The floor is covered with a three-piece rubber mat. One piece is laid on underfelt and bitumen-impregnated sheet on the toeboard; the second, which covers the front floor, is also on felt and impregnated sheet; while the third piece is laid on bitumen-impregnated sheet only on the rear floor. Where felt is used, it is stuck to the rubber.

A bench type seat is employed at the front as well as at the rear. The squab of the front one is divided and hinges forward to give access to the rear. The tubular framing of each half of the squab is extended over the top to form a handrail by means of which the squab may be moved forward without leaving dirty finger marks on the upholstery. The cushion is mounted on a single frame on four legs. The two front legs are pivoted at each end, while the two rear ones are fixed to the frame at their upper ends and have rollers at their lower ends which run in shallow dished tracks sunk in the floor. A simple device is provided to lock the seat in position after it has been adjusted.

The chromium plated rubbing strips on the lower edge of the doors and the sill of the Mercedes Benz 220 are protected by rubber inserts

A heater is installed in the air duct on the Mercedes Benz 220

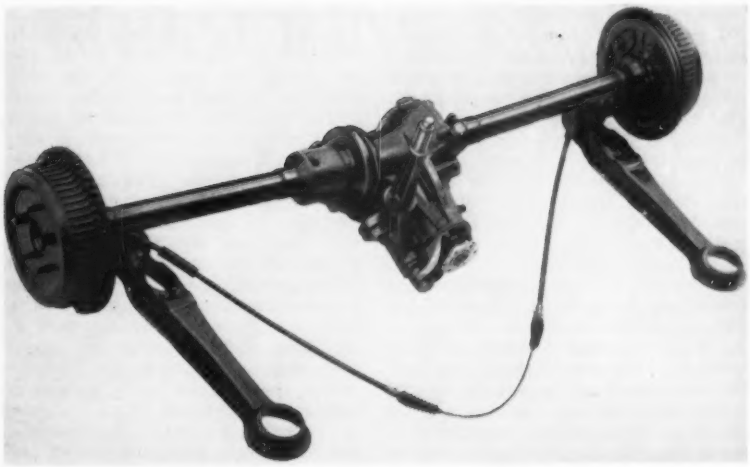
Unusually flexible rubber seals are secured round the door opening. They are of U-section, one arm of which is formed by a tubular beading and the other arm is solid. A metal strip is fixed between the arms of the U, and the whole assembly is secured to the body by self-tapping screws passed through this strip and the rubber. Below the waist, a second seal is fitted on the door, and where this seal butts against the inner one when the door is closed, a soft sponge rubber block is stuck to the pillar. This ensures that there can be no leakage at the junction.

The rear windows are pivoted at their front edges and can be opened about 2½ in by releasing the toggle clips at their rear edges. A small H-section frame is mounted round the glass. One pair of arms of the H are clamped astride the edges of the glass, and the other pair house the bulb-section base of a rubber sealing strip. This strip is pressed against the body panelling when the window is shut.

Triangular, glass ventilating panels

A Z-section pressing is welded to the centre pillar to conform with the body profile below the waist line of the Opel Kapitan

By stowing the spare wheel behind the wheelarch, no space is wasted in the boot of the Opel Kapitan



A single universal joint is employed in the swing-axle system of the Mercedes Benz 220

are incorporated at the front of the doors. The lower hinge on each is concealed and is of the spigot type, while the upper one is a simple painted component fabricated from sheet steel. The latch handle is unlocked by pressing a button that projects from the inner end of its spindle. This button is spring loaded, so that it locks automatically when the handle is turned back again. A drip channel is fitted outside the lower edge of the triangular panel to prevent water from running past the hinge and into the car. The leading edge of this channel is turned up and the trailing edge down, so that the water is discharged to the rear of the hinge.

Under the bonnet there is not a dash shelf; instead, the dash is bulged forwards so that the heater can be accommodated between it and the facia. This is a good feature, in that the inevitable losses from the heater unit pass to the interior of the car instead of under the bonnet. Thus, there is little, if any, waste of heat. A bracket spot-welded to the front of the dash carries the battery. The bonnet-lid hinge is spring loaded so that a prop is not required. There are no drip channels at the edges of the bonnet, and the water is simply allowed to run down the valances. The radiator is mounted on the body structure. It has two shoulders on each side and they rest on rubbers in vertical channel section brackets welded to the wheel arches. At the base, a single rubber mounting is interposed between the radiator and an inverted top hat section cross member.

Some of the features of the exterior panelling are of interest. The front apron is not a separate component, but is formed by the lower portion of the grille. Detachable front wings are employed and can be changed easily in the event of their being damaged. The rear apron is formed by the skirt panel, the lower edge of which is turned into the bumper section. This skirt, together with the boot surround and the rear quarters above the horizontal chromium strip on each side are in one piece. The panel that covers the rear wheels and extends forwards to the door pillar on each side is a separate piece. From the illustration it can be seen that with this arrangement there are no deep draws at this end of the vehicle. The horizontal joint-line is concealed over most of its length by the chromium plated strip, and the vertical joint at the rear is scarcely noticeable since it is in line with the centres of the reflector, and rear and stop lamps. The number plate illumination lamps are mounted on the inner faces of the upstanding portions of the overriders. Rubber blocks are bolted between the ends of the rear bumper and the body panelling. A petrol filler tube is welded to the rear skirt panel, where it is readily accessible from either the right- or left-hand side, and where damage is unlikely to be caused to the panelling by the filler hose.

The boot lid is mounted on concealed hinges and is spring loaded so that it does not have to be propped open. Inside, the spare wheel is strapped in a vertical position behind the seat squab. It is of interest to compare this arrangement with that on the Kapitan, in which the spare wheel is behind the wheelarch and leaves a maximum amount of space available for luggage. Because the Rekord is a smaller model, it has not been possible to stow the wheel behind the wheelarch in the same way.

Mercedes Benz

Mercedes Benz have introduced a new 220 model. It differs from the earlier one in that it has a larger body and accommodates six people. Another new feature is the back axle arrangement. The casing of the hypoid bevel final drive unit is carried on a bracket secured by means of a single rubber mounting, instead of two, on the frame, and only one universal joint is employed in the swing axle system. This joint is on the right-hand side. The left-hand axle, together with the final-drive casing, pivots about a pin carried between lugs on the mounting bracket. The axis of this pin is parallel to the longitudinal axis of the vehicle and in line with the centre of the universal joint. Thus, the effective length of the swing axles is as large as possible, so that the change of camber angle as the wheels move up and down is as small as possible. Furthermore, the pivot point is low down. All these features combine to lessen the tendency to sprag action when cornering fast, and they reduce tyre wear and improve the ride.

As before, the drag loads are taken by a single, rubber-mounted, trailing link on each side. Coil springs seat on these links. Attention has been devoted to brake cooling, and radial fins are incorporated on the outer periphery of the drum and on the flange

In the Mercedes Benz 220, a simple three-position adjustable stop is provided on each side at the base of the front seat squabs

round it. Air passes inwards through slots in the wheel discs and is centrifuged out by finning on the drums.

The 6-cylinder engine is fitted with an aluminium alloy head, and its compression ratio has been raised to 7·5 : 1. Improvements have been made to the torque characteristics at low and medium speeds, and the maximum engine speed is now 6,000 r.p.m. An increase, of 5 b.h.p., to 85 b.h.p. at 4,800 r.p.m., has been obtained. The bore and stroke are 80 mm by 72·8 mm respectively and the swept volume is 2,195 cm^3. The overhead camshaft arrangement has been retained and an oil-water heat exchanger is again incorporated. Four forward speeds and one reverse are obtainable with the gearbox, and selection of all the forward speeds is made through synchromesh units. The ratios are: top 1 : 1, third 1·52 : 1, second 2·32 : 1, first 3·40 : 1, reverse 3·29 : 1. An axle ratio of 4·11 : 1 has been adopted.

The overall dimensions of the vehicle are: length 15 ft 5½ in, width 5 ft 8½ in, height unladen 5 ft 1½ in. A wheelbase of 9 ft 3 in has been adopted, and the track is 4 ft 8 in at the front and 4 ft 9½ in at the rear. With two people in the vehicle, the ground clearance is 8½ in while fully laden it is 6·4 in. The turning circle is 36 ft. With the spare wheel and tools removed, the dry weight of the vehicle is 2,530 lb.

The front end styling in general is similar to that of the 180 and 300 models. A light, pressed radiator grille of traditional Mercedes Benz form is attached to the bonnet lid and lifts with it. A gap is left between the rear edge of the bonnet lid and the scuttle, so that warm air is directed to the windscreen. Not only will this tend to clear ice from the outside of the glass, but also, by warming the glass, will help to prevent the formation of condensation on the inside.

Head and fog lamps are faired into the body panels, and side lamps of elongated streamlined form are fitted on the wing crowns. This type of side lamp is becoming increasingly popular. Both the front and rear aprons are more or less vertical instead of horizontal, and are therefore easy to clean. The short lengths of irons visible between the apron and the bumpers are concealed by pressed steel shrouds. Interposed between the edges of the overriders and the bumpers are channel section rubbers. A one-piece bumper is fitted at the back, but the front one is in three pieces. The irons are 2 in by ¼ in strip. One extends across the front of the vehicle and its ends are turned back and bolted to the frame side members. It carries the centre portion of the bumper, which is divided to form a frame for the number plate. Two more irons, one on each side, extend out to a point in line with the side of the vehicle, but they are not wrapped round the front end, as are the outer portions of the bumper.

On the sides of the vehicle, two chromium plated rubbing strips at sill level extend almost the whole length between the front and rear wheels. These strips are protected by a rubber insert. Another chromium plated strip is used to accentuate the wing line over the rear door and quarter panel on each side.

Strips of this material are also fitted at waist level round the sides and rear of the canopy and on the doors. The drip channel, which extends along the cant rail on each side and down the front and rear pillars to the waist rail, is also chromium plated. A lock-up flap over the filler cap is incorporated low down on the rear quarter panel. Chromium plated garnish strips are fitted round all the windows.

When viewed from inside the car, the windscreen pillar adjacent to the driver does not obstruct the range of vision too much since, although wide, it is edge-on to the line of sight. Because of the curvature of the screen, the pillar on the opposite side to the driver is well back and out of the way. Moreover, it is relatively remote, so that the projected angle of the blind spot that it produces is small.

All the instruments are immediately in front of the steering wheel. A horizontal-reading speedometer, together with the various oil, water and fuel gauges and ammeter below it, are enclosed by a single bezel and glass of rectangular form. Below this is a horizontal row of control knobs and switches. A clock is mounted above the radio in the centre of the facia.

Two vertical control-quadrants, each carrying two levers, are fitted one at each end of the facia. One controls the heater and fresh air supply to the driver and the other is for a separate system on the passenger's side. Immediately above each quadrant is a circular jet, in the orifice of which is a butterfly valve. The jet and butterfly are chromium plated and are so arranged that together they direct air over the side lights on the front door for demisting purposes. The butterfly valve is actuated simply by pushing it with one finger.

A conventional arrangement of demister ducts is provided to direct air on to the windscreen, and another duct on each side below the dash supplies air over the occupants' feet. In the standard form, a heater is fitted on the driver's side, and only fresh air is obtained on the passenger's side. However, an additional heater can be fitted as an optional extra. The system is unusual in that the heater elements and fans are incorporated in the run of the two 4⅛ in diameter ducts which carry fresh air from each side of the radiator. These elements are supplied by Suddeutsche Kuhlerfabrik, Behr Feuerbach, Stuttgart, and their housings can hardly be much more than about 5 in square.

The front seats are adjustable for fore and aft position, and the squab angles can also be changed. This angular adjustment is provided for in a simple manner; the base of the frame on each side of the seat is extended downwards and forwards to form a lever, the end of which is pivoted at a point well forward of the rear of the cushion. A stop is fitted to the seat pan under the junction of this lever with the vertical part of the squab frame. This stop has a rubber pad on its upper face to prevent rattling when the seat is unoccupied. Two rubber-faced, steel distance pieces are hinged, one to the front edge of the stop and the other to the rear edge, in such a way that first one of them can be folded over on top of it to increase its effective height; then the second can be folded over on top of the other further to increase the height of the stop. Thus the squab can be set at any one of three angles. Judging by the flexibility of the squabs, there can be little or no stiffness in the cross bracing between the vertical side frames. Undoubtedly, this is to avoid any possibility of permanent deformation taking place as a result of failure to adjust the stops to the same height on each side.

On the front floor, a rubber covering is laid over timber ply. Felt, covered with rubber, is used on the toeboard and over the gearbox. A Boucle, woven carpet is fitted on the rear floor. Rubber covers are also fitted over the door sills in the interior of the car to protect them against damage by the shoes of passengers entering and leaving.

In the boot, a coil type compression spring is incorporated in each hinge to hold the lid in the open position when required. The steering wheel can be stowed either on the left- or the right-hand side in a well adjacent to the wheelarch. A jack and wheelbrace are carried in a clip in an accessible position immediately inboard of the wheelarch. A pressed steel clip holds the spare wheel clear of the wheelarch so that there is no chance of rattling. The floor of the boot is 37 in wide between the wheelarch on one side and the spare wheel on the other, and 40 in long.

SPRAYS

THE Texas Company, of 135 East 42nd Street, New York 17, has published a second edition of "The Penn State Bibliography on Sprays," which has been compiled by the Department of Engineering Research of the Pennsylvania State University. In the first 169 pages is an alphabetical list of authors, together with the titles and scope of their papers. Then follows a page on which is printed a subject index giving the following headings and the pages on which they are dealt with in the main index: Applications of sprays, atomization, atomizers, characteristics of sprays, chemistry of sprays, methods and apparatus used in spray research, physics of sprays, solid particles, and theory and fundamentals. The next thirty-eight pages form the main index, in which the appropriate authors are listed under each subject heading in turn. This work should be of use to engineers interested in these subjects, as well as to specialists.

CORNERING CHARACTERISTICS OF TYRES

An Improved Method for their Determination

By V. E. Gough*

UNTIL the present time there have been two main ways of plotting cornering force and self aligning torques of tyres (a) against slip angle, (b) against load. These notes describe a new method of plotting that has advantages over both (a) and (b). One chart suffices for both cornering force and self aligning torque instead of the two properties being recorded on two separate graphs.

A plot of cornering force versus self aligning torque for a range of applied vertical loads (with curves of constant slip angle drawn in), is considered to be the characteristic curve for the tyre at a given pressure. The chart enables pneumatic trail (or tyre castor) to be read off readily in addition to permitting any of the graphical calculations possible on the earlier charts. The characteristic curve also gives information on the handling characteristics which arise from the tyre. Some typical characteristic curves are given. In addition, the method of investigating the effect of king pin castor on aligning torques (at the king pin) for a given tyre characteristic curve is described. It is graphical and simple. A number of cases are investigated and it is shown that even when the same maximum torque is achieved the handling characteristics may differ considerably. Cases involving load transfer are given, it being found that steering torques are always increased by load transfer. Load transfer can also alter the relation between various selections of tyre pressure and mechanical castor compared with the no load transfer case. In practice each case requires to be investigated on its own merits.

*Physical Research Division. Dunlop Research Centre.

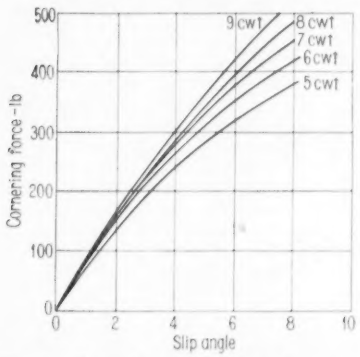


Fig. 1. Cornering force-slip angle curve. Tyre 6.40/15 C.T., 24 lb in² I.P.

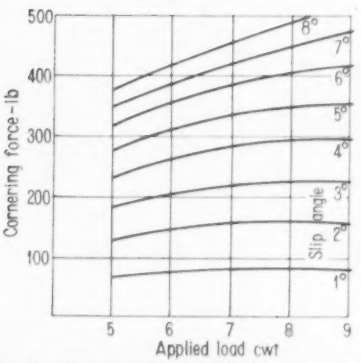


Fig. 3. Cornering force-applied load curve. Tyre 6.40/15 C.T., 24 lb in² I.P.

It is common for tyre manufacturers to present cornering force and self aligning torque data on a rolling tyre in two graphs:—

(a) Cornering force against slip angle.
(b) Self aligning torque against slip angle.

According to the problem on hand, several graphs are plotted on each chart, for example, they may be for either:—

(1) Various inflation pressures.
(2) Various loads.
(3) Various rim widths, or
(4) Different size tyres.

This method of presentation arises largely because in the actual testing the slip angle is the independent variable and C.F. and S.A.T. dependent variables (Figs. 1 and 2).

On the other hand, the user (the vehicle manufacturer) often replots the data in the form:—

(a) Cornering force against load.
(b) Self aligning torque against load and curves for a range of slip angles are plotted on each graph (Figs. 3 and 4).

The reason for vehicle manufacturers' preference for this form of presentation is that the total cornering force for two unequally loaded wheels, both operating at a common slip angle but allowing for load transfer (as when negotiating a bend) can readily be found graphically (Fig. 5). It is also possible to use such a chart even if the slip angles differ owing to steering geometry or compliance of steering links.

Proposed new method of presentation of data

In actual usage the real problem before the designer is two-fold:—

(a) The provision of adequate cornering force to cause the vehicle to negotiate the curve.
(b) A knowledge of the self aligning torque arising (plus certain other determinable couples arising from the vehicle design) for this determines the steering effort.

Furthermore, it is the relationship between steering torque and cornering force set up which determines the "feel" or "handling" of a vehicle. Fundamentally, then, cornering force data plotted as a curve of cornering force against self aligning torque gives the essentials of the tyre characteristics from a handling point of view. Bearing in mind the points relating to load transfer, and possible slip angle differences, it is clear that a chart should be plotted with curves covering a range of applied vertical loads and slip angles.

The resulting chart is as shown in Fig. 6 and it could justifiably be called the characteristic curve of the tyre. This completely describes the tyre properties at the given pressure and rim width. The chart could be plotted

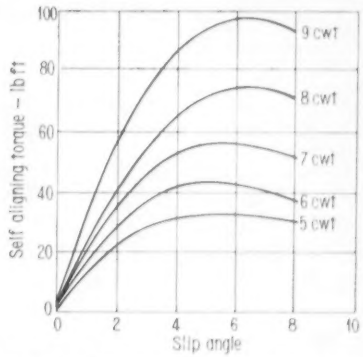


Fig. 2. Self-aligning torque-slip angle curve. Tyre 6.40/15 C.T., 24 lb in² I.P.

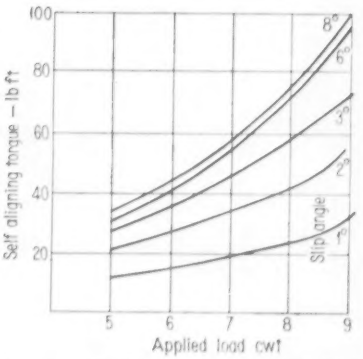


Fig. 4. Self-aligning torque-applied load curve. Tyre 6.40/15 C.T., 24 lb in² I.P.

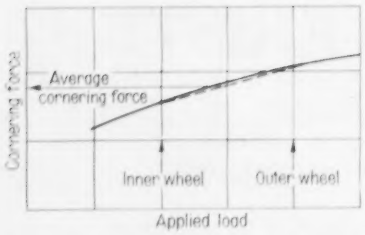


Fig. 5. Conventional method of calculating cornering force when load transfer causes unequal tyre loads

the opposite way round but S.A.T. is put as abscissa because the user applies a torque and obtains a cornering force. However, this is not an important point. The grid of radial lines in Fig. 6 is explained below (pneumatic trail).

Use of the characteristic curve

Simple uses, such as given any three of the following find the fourth,

(a) Load.
(b) Slip angle.
(c) Cornering force.
(d) Self aligning torque

need no comment.

Problems involving load transfer are readily dealt with in the case of known loads and slip angles (which may or may not be equal). The points of intersection of load and slip angle for each wheel are located and the total C.F. and S.A.T., found directly.

If the conditions of operation of two tyres at (say) equal slip angles with a known load transfer ratio to produce a given C.F. are required, it is simply a matter of graphical "jugglery" to find the appropriate points (Fig. 7).

Draw a line (a-b) at the given C.F. from the axis to the curve corresponding to the average load C. Locate the curves c and e corresponding to the two loads allowing for load transfer. Draw a straight line through b cutting the curves d and e at points f and g at the equal values of slip angle. This is a simple trial and error process. Join points f and g and bisect. At convenient adjacent slip angle values join points j and k and bisect as at l. Join bisection points in a curve intersecting ab or ab continued at m. A line nmo joining points of equal slip angle on d and e locates n and o, the two operating points for the inner and outer wheels. C.F. and S.A.T. values for each can be read off.

More complex cases, in which slip angles differ owing to the geometry, or even those in which deviations from the theoretical angles arise owing to compliance of the steering mechanism can be dealt with, at least on a trial and error basis.

Pneumatic trail or tyre castor

As $\frac{\text{S.A.T.}}{\text{C.F.}}$ = pneumatic trail or tyre castor, a grid of radial lines through the origin represent a range of values of pneumatic trail. These are shown in Fig. 6. They enable the values of pneumatic trail at any known condition to be read directly. Tyre castor can also be expressed as an equivalent angle —equal to the angle subtended by the pneumatic trail at a radius equal to the standing radius of the tyre.

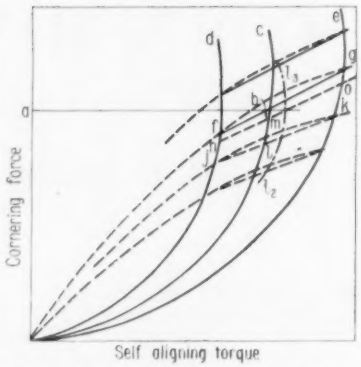


Fig. 7. Method of estimating on the new diagram cornering force under conditions of unequal load due to load transfer

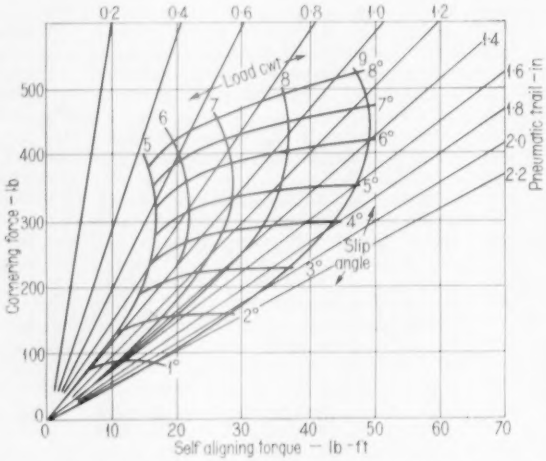


Fig. 6. Cornering force-self aligning torque. Tyre 6.40/15, rim 4½ J, 24 lb in²

Effect of Inflation Pressure

Figs. 6, 8 and 9 give data on 6.40/15 C.T. tyre on a 4½ J rim for 24, 20 and 16 lb/in² inflation pressure. Inspection of these curves gives some idea of the influence of load and pressure over the usual working range of slip angle.

Characteristic curve for higher slip angles

Fig. 10, which is based on aero tyre data obtained and used for the computation of undercarriage reactions during ground manœuvres, indicates the form of the curve for high slip angles. Although not shown on this curve the reversed or leading aligning torque reaches a maximum at a slip angle of around 25 or 30 deg and then falls slightly. At 90 deg slip

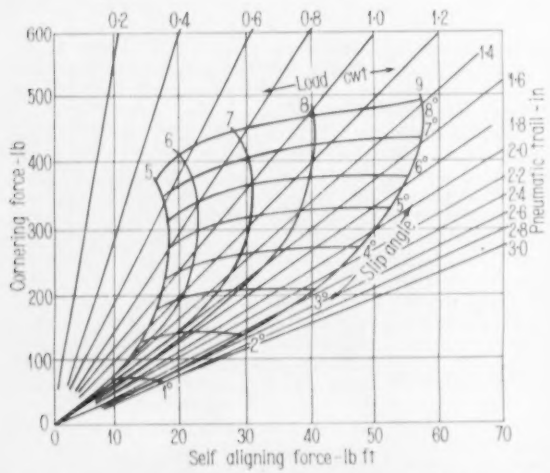


Fig. 8. Cornering force-self aligning torque. Tyre 6.40/15, rim 4½ J, I.P. 20 lb in²

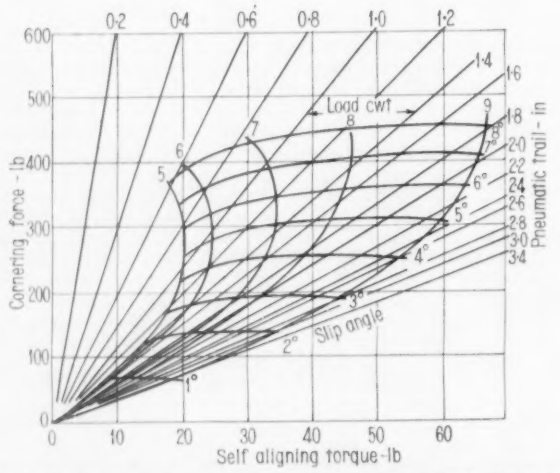


Fig. 9. Cornering force-self aligning torque. Tyre 6.40/15, rim 4½ J, I.P. 16 lb in²

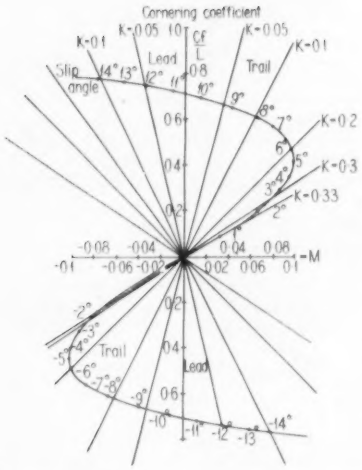


Fig. 10. Characteristics for positive and negative slip angles

angle the reaction is a simple frictional drag.

This curve is plotted in non-dimensional form. Cornering force is given in the form cornering coefficient (cornering force divided by load), self aligning torque as a torque coefficient in terms of load, deflection and diameter; and pneumatic trail as a trail coefficient in terms of deflection and diameter. The deflection and diameter settle the contact length and so effectively pneumatic trail is given as a function of contact length while the self aligning torque is virtually in terms of load and contact length (See appendix).

In most practical applications it is adequate to plot only part of the curves as in Figs. 6, 8 and 9, but Fig. 10 serves to illustrate the remarks in the next section. Referring to Fig. 10, the cornering coefficient $=\frac{C.F.}{L}$, the trail coefficient $K=\frac{P.T.}{\sqrt{D\delta}}$ and the torque coefficient $M=\frac{S.A.T.}{L\sqrt{D\delta}}$ where

L = Load on tyre.
C.F. = Cornering force.
P.T. = Pneumatic trail.
S.A.T. = Self-aligning torque.
D = Tyre diameter.
δ = Tyre deflection.

Indications of handling characteristics

A curve which gives a progressive relation between the two quantities (cornering force and S.A.T.) over the working range indicates that the "feel" at the steering wheel is at all times a measure of the side force being called into play at the tyre (a, Fig. 11). On the other hand, the portion of a curve which shows little or no change in cornering force corresponds to a region where the feel at the steering wheel gives no indication of changes in side force at the tyre (b, Fig. 11).

Furthermore, if the self aligning torque decreases with increase of side force the condition would correspond to a feeling of incipient sideway skidding (c, Fig. 11), and finally, if the curve has passed the cornering force axis then as far as the tyre is concerned, torque has to be applied to restrain the steered angle from increasing and the vehicle has gone "beyond the limit" and is tending to "broadside" (d, Fig. 11).

In this connection of handling it will be remembered that the user of the vehicle knows only some or all of the following:—

(a) The cornering force he is achieving.
(b) The steering wheel torque he is applying or resisting.
(c) The position of the steering wheel.
(d) The course of the vehicle.
(e) The attitude of the vehicle.

He does not know the slip angle at any time although his knowledge of a, b, c, d, or e may give him some approximate idea of its magnitude. While e gives him a good idea of the slip angle at the rear tyre his knowledge of the front tyre slip angle is very indirect. Clearly, then, the relegation of the slip angle to a subsidiary role in the chart instead of retaining it as the independent variable is a justifiable step.

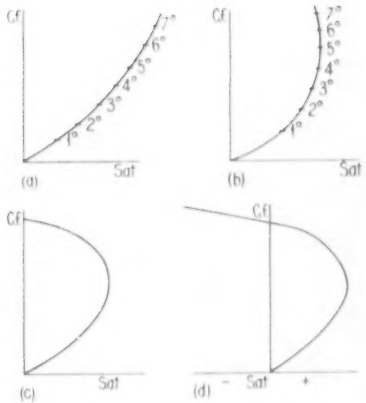


Fig. 11. Essential points regarding characteristic curves

(a) progressive relation between C.F. and S.A.T.
(b) curve for case where S.A.T. varies but little for wide changes of C.F.
(c) region of characteristic curve where S.A.T. falls with rising C.F.
(d) region of characteristic curve where S.A.T. is negative and torque is required to restrain steered angle from increasing

Steering torque

It has been shown that the two major factors contributing to steering torque at the king pins are the self aligning torque of the tyres plus the product of cornering force and castor due to the king pin angle. The moment of the tyre drag of one wheel is balanced by the other wheel and in any case, except during braking, these forces are small. The steering torque at the king pins is then given by the product of the tyre cornering force and the sum of the pneumatic trail of the tyre and the mechanical trail due to king pin castor angle.

Method of allowing for influence of castor of the king pin

The nature of the characteristic curve is such that a graphical method of allowing for the influence of castor of the king pin is easy and practicable. In

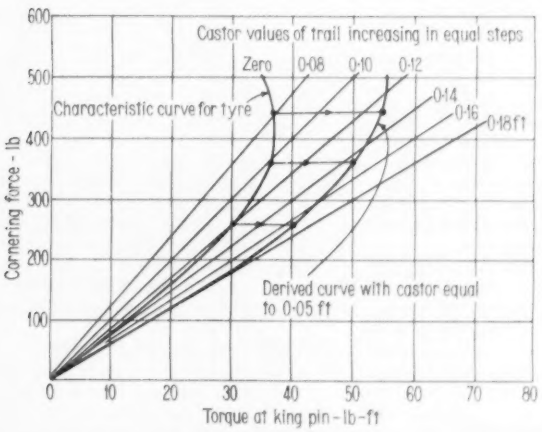


Fig. 12. Basic method of deriving curve for known castor trail

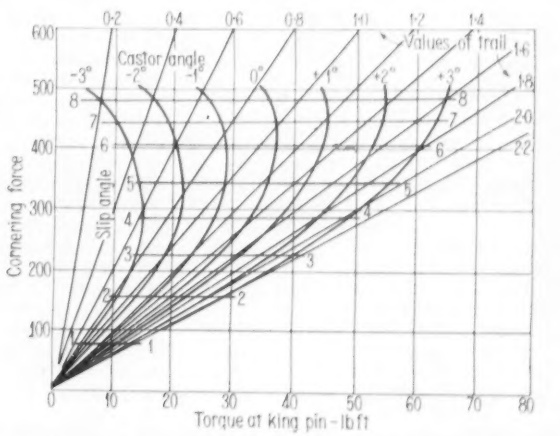


Fig. 13. Effect of castor on 6.40/15 C.T. tyre at 24 lb in² pressure carrying 8 cwt.

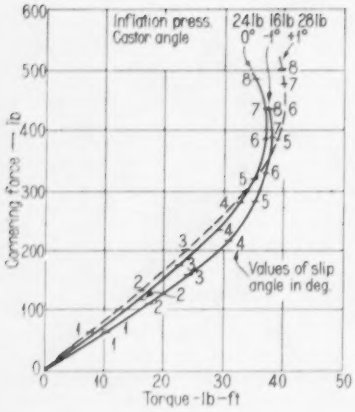


Fig. 14. Comparison of three cases of 6.40/15 C.T. tyre carrying 8 cwt.

Fig. 12 the axes are torque at the king pin, and cornering force. With zero castor the curve is the characteristic curve of cornering force versus self aligning torque and is shown as curve for castor = O. The sloping lines correspond to trail and the values are given by the ratio of torque to cornering force. In the case of the curve for castor = O the values read off the intersections of the curve and the trail lines are the pneumatic trail values.

For castor of 0·05 ft (arbitrarily chosen for example only) the curve is obtained by noting the intersection points with the sloping lines at the same cornering force plotting a point on the appropriate sloping line corresponding to an increase of trail of the required amount (0·05 ft). The horizontal lines indicate the process. The required curve is obtained by drawing a curve through the points so derived. An example of the effect of castor is shown in Fig. 13.

From similar plots covering a range of loads and pressures it is found that the magnitudes of torques and shapes of characteristic curves are seriously influenced by the choice of castor angle and tyre pressure and load. As the slip angle-cornering force relation is not altered, the lines of constant slip angle are lines of constant cornering force and are horizontal lines on the chart.

The relation—mechanical trail (or castor trail) equals castor angle times standing height—is used to obtain the amount by which the curves are offset from the basic curve. The sloping lines are marked with trail values—this is the total trail, that is the sum of pneumatic trail and castor trail.

It is very difficult to draw any universal general conclusions regarding castor except to note that the diagrams do confirm that negative castor, while it reduces the torque, replaces a responsive characteristic with progressive feel by one with a "flat spot" where changes in cornering force are not accompanied by changes in torque. To study a given case the charts for the appropriate conditions must be drawn.

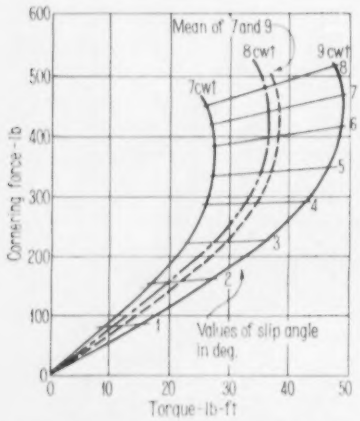


Fig. 17. Effect of a load transfer of ±1 cwt. on a mean load of 8 cwt. I.P. 24 lb in², zero castor angle

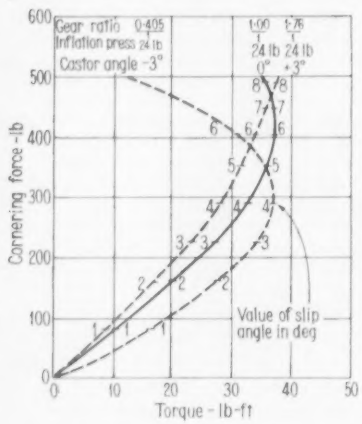


Fig. 16. Comparison of three cases of castor angle with steering gear ratio modified to give same maximum self-aligning torque. Load 8 cwt.

Examples of comparisons which can be made on the diagram.

Fig. 14 compares three cases giving about the same maximum torque.

(a) 16 lb/in², −1 deg castor
(b) 24 lb/in², zero castor
(c) 28 lb/in², +1 deg castor

all at 8 cwt load.

While there is little to choose in the shape of the curves, case (c) seems to have a slight advantage in regard to progressiveness of feel. Figs. 15 and 16 compare the curves obtained when castor is changed and the steering gear ratio altered to retain the same maximum torque. Fig. 15 compares +1 deg and −1 deg with the zero castor case and shows but small effect.

On the other hand, curves relating to +3 deg and −3 deg in Fig. 16 show that big changes in characteristic are to be expected. (Note that gear ratios are very different in each case and this would alter the handling assessment somewhat.)

Effect of load transfer

As stated above, the effects of load transfer can be assessed on the charts.

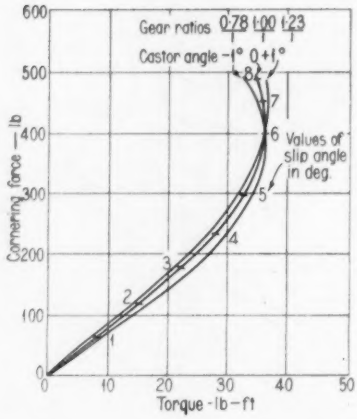


Fig. 15. Comparison of three cases of castor angle with steering gear ratio modified to give same maximum self-aligning torque. I.P. 24 lb in², load 8 cwt.

Fig. 17 shows the small effect of ±1 cwt load transfer on a mean load of 8 cwt when the tyre at 24 lb has zero castor. This figure also indicates the derivation of the load transfer case.

Fig. 18 compares the three cases of Fig. 14 but under the condition of load transfer of ±1 cwt on a mean of 8 cwt. What were small differences are now magnified and it is seen that as regards shape of characteristic the 16 lb with −1 deg castor is inferior to the 28 lb with +1 deg castor although their torques have same maxima. The 24 lb with zero castor has a lower peak value. These effects are largely due to the greater change in the 16 lb, −1 deg castor case. Load transfer, in all cases, appears to increase the maximum torque.

Conclusion

With this new form of presentation of data of cornering force and self aligning torque, a single chart suffices for all the data and exhibits the characteristic features of the tyre's behaviour. All the usual calculations can be made with the chart and also many other

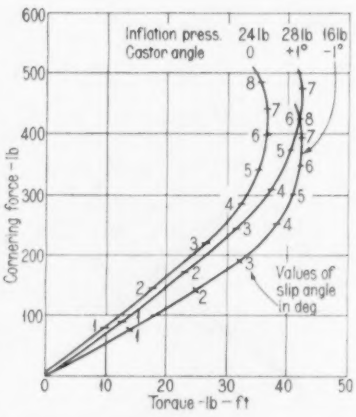


Fig. 18. Comparison of three cases of 6.40/15 C.T. tyres carrying a mean load of 8 cwt. with load transfer of ±1 cwt.

characteristics are more readily deduced.

In particular, curves showing the influence of castor, with or without load transfer, on the characteristic curve can be readily derived. Changes of tyre pressure, mechanical castor, and steering gear ratio are related in a very complex manner and any specific combination requires to be studied as it may be required. Considerable differences in handling (arising from the shape of the characteristic curve) can arise even when the peak torques are the same.

Acknowledgment is made to the directors of the Dunlop Rubber Co. Ltd. for permission to publish this article.

Appendix

Non-dimensional coefficients used in Fig. 10.

The data is given in terms of

$$\text{Cornering coefficient} = \frac{\text{Cornering force}}{\text{Load}}$$

$$\text{Trail coefficient} = \frac{\text{Pneumatic trail}}{\sqrt{D\delta}}$$

where D = outside diameter of tyre
δ = deflection of tyre.

It should be noted that $\sqrt{D\delta}$ is equal to half the theoretical contact length. The actual contact length is found to be given by the empirical formula $1{\cdot}6\sqrt{D\delta}$ instead of $2\sqrt{D\delta}$. Basically, however, the trail coefficient relates the pneumatic trail to contact length and is non-dimensional.

Now taking pneumatic trail as defined by

$$\frac{\text{Self-aligning torque}}{\text{Cornering force}}$$

it remains to define a torque coefficient as

$$\frac{\text{Self-aligning torque}}{\text{Load}\sqrt{D\delta}}$$

for equation.

$$\frac{\text{S.A.T.}}{L\sqrt{D\delta}} = \frac{\text{CF} \cdot \text{PT.}}{L \cdot \sqrt{D\delta}}$$

or Torque Coefficient = Cornering Coefficient × Trail Coefficient.

TRADER HANDBOOK 1954

THE 1954 edition of that invaluable legal, technical and buying guide for the motor, motor cycle and cycling trades, the *Trader Handbook*, appears in a new format that makes reference to the desired information even easier than it was in previous editions. There are six sections, each clearly indicated by a guide card with thumb index and each printed on distinctively coloured paper. These sections are: Technical and General (Motor), Technical and General (Motor Cycle and Cycle), Transport Service Equipment, Buyers' Guide, Proprietary Names and Trade Addresses. All this information is found in 516 demy-octavo pages bound in paper boards.

As usual, the contents have been checked throughout and brought up-to-date. The result is a practical and comprehensive treatment of all the relevant aspects of the motor, motor cycle and cycle trades that provides accurate answers to the daily problems of buying, selling and servicing. The Handbook will also be of great value to overseas firms seeking contact with British firms.

In the Technical and General Section (Motor) there are comprehensive lists of vehicle manufacturers with vehicle specification details. This section also includes data for vehicle servicing, fill up, front end service and oil producers S.A.E. numbers. In addition it includes comprehensive lists of suppliers of spare parts, repairers, wholesalers and trade associations. In this same section there is a legal guide, an index of registration numbers, lists of licensing authorities and traffic headquarters, and the latest wage rates in the motor trade.

The Technical and General Section (Motor Cycle and Cycle) lists three-wheeler, motor cycle and cycle manufacturers. It gives vehicle and engine specifications, rim standards, frame angles, hub and brake lining dimensions and gear ratios. Information is also given concerning thread and tapping sizes, recommended lamp bulbs and spoke lengths. There are lists of suppliers, repairers, repair charges and wholesalers. A legal guide, a list of associations and the latest wage rates for the motor cycle and cycle trades complete this section.

Those interested in the sale or use of garage equipment will find valuable information in the Transport Service Equipment Section. This section gives an up-to-date and comprehensive list of firms that specialize in the manufacture or the sole distribution of garage and workshop equipment for manufacturers and repairers. The Buyers' Guide Section gives the names of manufacturers and sole distributors of motor, motor cycle and cycle accessories and components, while approximately 5,000 brand names attached to such goods are listed in the Proprietary Names Section.

This mine of information is published at 12s. 6d. (by post 13s. 0d.) by the Trader Publishing Co. Ltd., Dorset House, Stamford Street, London, S.E.1.

SCAVENGING THE TWO-STROKE ENGINE

DURING the last few years, the Sloan Laboratory at the Massachusetts Institute of Technology has prepared recommendations concerning the terminology to be used in connection with the scavenging of two-stroke engines. They have also determined how the actual scavenging of two-stroke engines may be compared with an ideal scavenging process. This work is described in an article entitled "Scavenging the Two-Stroke Engine," by C. F. Taylor and A. R. Rogowski, in an *S.A.E. Preprint*, November 3-4, 1953. Diagrams of various cylinder types are included in the article, and they differentiate between *loop-scavenged* engines, in which all the ports are at one end, and *through-scavenged* units, where the inlet and exhaust ports are positioned at opposite ends.

In *perfect* scavenging, the fresh mixture is said to push all the combustion products before it, without mixing and heat exchanging taking place. Under these conditions, the *ideal* quantity of air is delivered to the cylinder. *Scavenging efficiency* is defined as the mass of fresh dry air retained in the cylinder after the scavenging process is complete, divided by this ideal quantity. The *scavenging ratio* is defined as the mass of dry air actually delivered per cycle through the inlet ports of the cylinder, divided by the ideal air quantity. Another definition concerns the *charging efficiency;* this is the fraction of the fresh air delivered which is actually retained when the ports are closed.

Theoretical relationships between these three measurements for various conditions, including perfect scavenging, perfect mixing, and complete short-circuiting, indicate the range of possibilities, although some of the measurements are difficult to make. The scope for improvement of a given two-stroke engine design is unknown unless the relationship between scavenging efficiency and scavenging ratio is determined. Measurement of scavenging ratio, or air supplied, is relatively simple and can be done by using a rig incorporating a square-edged orifice and suitable surge tank, but the measurement of scavenging efficiency, or fresh air retained, is difficult since it cannot be obtained directly.

One method is to use monomethylamine as a tracer gas, but difficulties arise through dissociation. A two-sample method, in which the gas analysis during compression and expansion is compared, has also proved effective provided an opening through which samples can be taken is available or can be made in the cylinder head. Another method suitable for spark-ignition engines is based on the i.m.e.p. It was concluded that, for engines scavenged with a carburetted mixture, the i.m.e.p. method of measuring scavenging efficiency is preferable, but for engines in which fuel is injected after the closing of the port, the use of a single expansion sample was most convenient and accurate. The effect of design on flow co-efficient, and the general effects of port height, and cylinder size are discussed. *M.I.R.A. Abstract No.* 6592.

CHUCKING AUTOMATICS

Two New Wickman Machines

ADDITIONS to the range of multi-spindle automatics designed and manufactured by Wickman Ltd., Coventry, are shown in the accompanying illustrations. These are chucking machines developed from the successful four- and six-spindle series of bar automatics. The four-spindle machine shown in Figs. 1 and 2 provides 9 in chuck capacity, while the six-spindle machine shown in Fig. 3 has 7¼ in chuck capacity. Many of the special features that have characterized the Wickman range of multi-spindle automatics have been retained in the new machines. Notable among these is the patented lever adjusting mechanism that allows tool feed strokes to be altered without any changing of cams.

Power is supplied by a 30 h.p., 960 r.p.m. foot-mounted motor on a hinged platform, the drive being transmitted through heavy matched vee belts. On each machine there are 24 spindle speeds, ranging from 29 to 473 r.p.m. on the four-spindle and from 51 to 675 r.p.m. on the six-spindle machine. The power and the feed and speed ranges have been chosen to cover the widest field of use.

The spindles are made from heat-treated steel forgings. They have large integral flanges for mounting chucks and run in extra precision taper and parallel roller bearings. A large multi-plate clutch and brake operated by an individual fork is fitted to each spindle. Air cylinders operate the spindle clutch, brake and chuck. They have a long draw-bar stroke and are of the tandem type on the six-spindle machine and of the single type on the four. Each is provided with its own combined running joint and valve of new design, a simple reversing valve for external or internal gripping control, and a pressure safety switch that can be arranged to trip the feed if the air pressure falls below a pre-set minimum safety value. Light action levers electrically control the air cylinders, and interlocks prevent incorrect sequences.

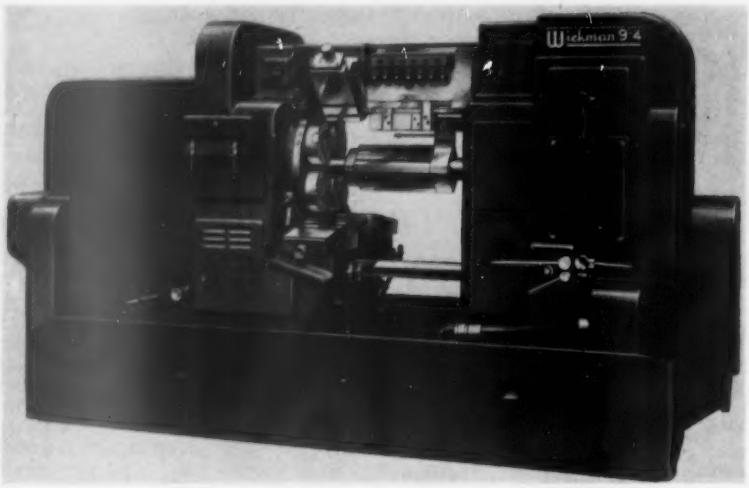


Fig. 1. Wickman four-spindle chucking automatic with 9 in chuck capacity

Under normal operating conditions, with no tooling in the loading station, the spindle is automatically stopped after indexing is completed ready for unloading the machined component. When accelerated and end working tooling is used in the loading station, adjustable timing cams stop the spindle automatically only when the tools are clear of the work. Operator safety is ensured by two-hand push-button controls linked with a warning light system and by a mechanism that trips the feed clutch automatically before indexing if the buttons have not been depressed.

The chucks are supplied with interchangeable base jaws and with either 10 deg wedges to provide the greatest gripping power or 15 deg wedges to provide the greatest movement. With 10 deg wedges the travel per jaw is 0·22 in and with 15 deg wedges 0·33 in. Loading is performed right-handed at the sixth station on the six-spindle machine and at the fourth station on the four-spindle. The indexing is anti-clockwise so that the heavier roughing operations are carried out at the lower stations. Double indexing can be arranged on the six-spindle machine, in which case loading is carried out at the fifth and sixth stations with individual controls to each station.

Cross slides are fitted as standard at the first and second stations on both machines. If required, they can also be fitted at the third and fourth stations on the four-spindle and at the fifth and sixth stations on the six-spindle machine. All cross slides have micrometer adjustment and are provided with a master stop that engages stop screws in the spindle drum.

The main tool block is provided with a dead stop and step-by-step endwise adjustment so that, dependent upon the length and swing of the work, the stroke and the tooling, the most favourable position for the set-up can be used. Independent upper end-working slides are also available for the fifth and sixth stations of the six-spindle and the third and fourth stations of the other.

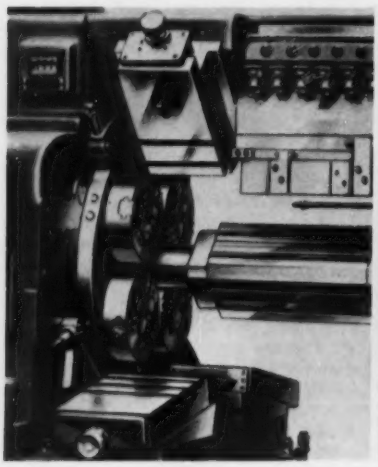


Fig. 2. Tooling area on the four-spindle automatic

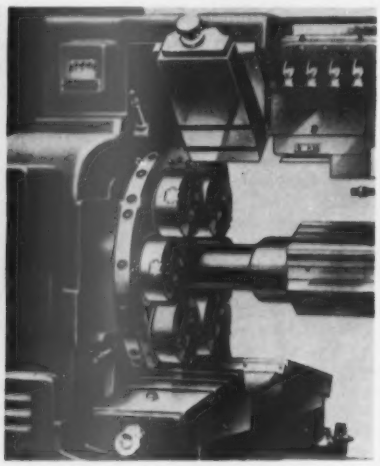


Fig. 3. Tooling area on the six-spindle automatic

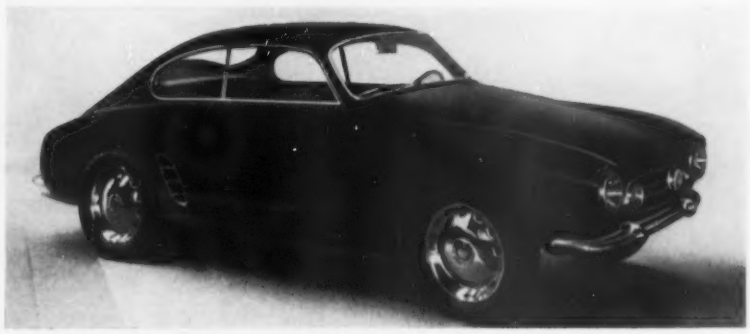
CONTINENTAL COACHWORK

Some of the Custom-Built Bodies at the Geneva Show

IN this country, custom-built coachwork is still almost invariably associated with the larger and more expensive chassis, but Continental practice as exemplified at Geneva shows a distinct trend towards the development of coach-built bodies for smaller and less expensive chassis made in large quantities. For instance, examples of the coachbuilders' art were shown on Renault 4CV, Panhard Dyna 54 and Volkswagen chassis. No doubt, this practice has been adopted with the aim of securing a wider market for these custom-built vehicles.

Last year, binnacle type instruments carried on the steering column were popular, but this year, scarcely any examples of this arrangement were to be seen either among the custom-built coachwork exhibits or the quantity produced cars at the Show. However, many manufacturers have adopted an arrangement which is somewhat similar but in which most of the instruments are grouped together on the dash immediately above the steering column. It is surprising to find that in many of the very expensive custom-built cars the provision for parcels, gloves, maps and handbags is totally inadequate.

So far as external styling is concerned, there seems to be no marked preference for any particular front end arrangement except that the manufacturers of sports cars tend to favour the jet-type air intake. Almost without exception, the rear wings of all types of vehicle have up-standing crowns and the rear lamps are mounted in the trailing edges. A feature that is becoming increasingly popular on all types of car is rear quarter lights hinged at their leading edges and secured by toggle clips at their trailing edges. The popularity of this feature is probably due to the fact that it is inexpensive and tends to give ventilation without draught. Moreover, it occupies less space than the more conventional types of window lift mechanism.



The GFH bodied Renault 4CV was the smallest among the coachbuilders' exhibits at the Geneva Show

A noteworthy feature of the Pinin Farina body on a Fiat 1100 chassis is the front end treatment. A grille opening of more or less rectangular shape is employed, and the somewhat plain and ugly appearance of this type of grille is changed, to give a pleasing effect, by the incorporation inside it of a two-piece chromium plated, horizontal bar with a V-arrangement at the centre. Many manufacturers fit a chromium plated frame round this type of grille opening and this tends unduly to accentuate lines which in many cases are not in harmony with the general conception.

An air intake scoop is incorporated near the front of the bonnet lid. In plan view, it tapers towards the front, and the general line is continued forwards by the latch handle, which is a chromium plated lever pivoted about an axis normal to the panelling, the motif over the lip of the grille opening, and the V in the centre of the grille. The rear edge of the front bumper is shaped to follow the contours of the body. This arrangement has not been used to obviate the need for an apron. A three-piece rear bumper is supported on short irons. The ends of the outer two pieces are wrapped round and rubber-mounted on the rear quarter panel.

Evidently the original sills of the unitary structure have been retained and the coachbuilder has fitted his body panels over them. A capping piece is fitted over the lower flanges to avoid having to introduce a large area of plain sill, which would have given an unpleasant effect. A chromium plated plug is sprung into the tubular jacking attachment under the centre of the sill on each side. The exterior of the car displayed was finished in egg-shell blue. Inside, the tops of the seat squabs and the front portions of the cushion were trimmed with brown leather while the remainder was covered with fawn cloth. The facia and waist cappings were in chocolate brown.

On the Allemano stand, a deep crimson sports coupé on a Dyna Panhard 54 chassis was shown. The trim was in a very light brown and the dash facia was painted deep crimson. An unusual feature of this vehicle is the passenger's seat. This seat is of the bucket type, the squab of which is hinged so that the passenger can sleep in a reclining position. When the squab is in the "up" position, two strips of steel projecting from the base of its front edges register in sockets in the cushion sides and a spring loaded lever with a peg on its inner face engages in a hole in each strip to lock it. The top portion of the squab can be extended to form a headrest, which is particularly useful when the squab is in the reclined position.

Ghia, of Aigle, also showed some bodies on the Dyna 54 chassis. One of these was the Grand Sport model and another was a Coupé de Luxe. The sports model has a jet type air intake to direct air over the air-cooled

A noteworthy feature of the style of the Pinin Farina Fiat 1100 is the radiator grille arrangement

The rear view mirrors on the Fiat 1900 body, by Ghia of Turin, are styled so as to appear to be part of the car instead of, as is often the case, attached as an afterthought

Smaller chassis are becoming increasingly popular as a basis for custom-built coachwork. An example is this Panhard Dyna 54 Coupé de Luxe model by Ghia of Aigle

This Grand Sport Panhard Dyna 54, with a body by Ghia of Aigle, weighs only 1,144 lb. It has a jet type air intake which hardly looks as effective as that of the touring model in directing air over the air-cooled engine

The bullet-like appearance of the Fiat V8 body, by Ghia of Turin, should appeal to certain types of sports car enthusiasts. Its bumpers are probably more ornamental than useful

engine, although from the point of view of cooling efficiency, the horizontal opening of the Coupé de Luxe model would appear to be better. Two rearward facing vents in the bonnet lid of the Grand Sport direct warm air over the windscreen. The bucket type seats of this model each have two horizontal slots in their squabs to provide ventilation in hot weather. They are also fitted with safety straps.

To save weight, a special frame has been designed for this vehicle. It consists of a tubular backbone attached at its front end to a complex bracket that carries the engine and front suspension and at its rear end to a cross tube on which is mounted the rear suspension. Another cross member of light construction is fitted immediately behind the bracket for the engine and front suspension units, and box section side members are welded between the front and rear cross members. Extensive use of lightening holes has been made in the front cross member and the two side members. The frame weighs 77 lb, and the weight of the complete vehicle is about 1,144 lb. At the rear, bumpers are not fitted.

The bumpers on the Coupé de Luxe are mounted directly on the body panels and therefore can hardly afford much protection. A bench type front seat is employed and part of its squab is shaped to fit the driver's back. At waist level, the overall width of the squab is 61 in, 16 in being taken up by the shaped portion for the driver. Foam rubber is used on the occasional seat at the back. The weight of the vehicle is about 1,440 lb.

Ghia of Turin displayed coachwork on two different Fiat chassis. One is powered by the V8 engine and is a fixed head sports coupé. Despite the relatively short length of the V8 engine layout, an exceptionally long bonnet has been adopted and it is evidently intended to give the impression of housing an engine capable of immense power output. As can be seen from the illustration, the overall styling of this vehicle gives it the appearance of a missile and should appeal to some sports enthusiasts. Most of the space provided for luggage is behind the bucket type seats, and straps are furnished so that the suitcases can be securely stowed. There is a small amount of additional space for luggage on top of the spare wheel in the boot.

The body on the 1900 chassis is of the convertible type. A canvas tonneau cover conceals the hood when it is in the stowed position. A number of detail features on this vehicle are of interest. For instance, the external rear view mirrors are styled to appear to be part of the vehicle rather than to be an accessory put on as an afterthought.

As can be seen from the illustration, the grille arrangement is somewhat unusual. The extreme ends of the horizontal portion could be useful if employed to direct cooling air on to the brake drums, but unless carefully designed ducting could be incorporated, there would be a danger of mud being slung forward through them and disfiguring the front of the car. The overriders are small and are integral with the bumpers both at the front and at the rear.

The graceful appearance of the Beutler Volkswagen is to a large extent due to its slender pillars and roof panel

An unusual feature of the Graber Bentley is the vertical chromium strip on the panelling in front of the rear wheels

In the Panhard Dyna 54 Grand Sport model, by Ghia of Aigle, safety straps are provided on each of the front seats, and there are two holes in each of the squabs to afford ventilation to the backs of the occupants in hot weather

An unusual feature of the Allemano body on the Panhard Dyna 54 chassis is the seat on the right hand side. The portion behind the occupant's shoulders can be extended to form a headrest and the whole squab can be hinged back

The door handles are of large section and tend to conceal the push buttons that are immediately below their rear ends. An unusual feature in the interior of the car is that the front arm rests are extended to the rear edge of the door which, of course, is well behind the front seat squabs. Separate arm rests are fitted on each side of the rear seats.

An exceptionally low-built sports coupé was shown by GFH. It is based on the Renault 4CV chassis. Its low build has been obtained by sinking the two bucket type front seats in wells in the floor and by placing the rear occasional seat cushion directly on the floor. When sitting in the car, the driver positively feels as if he is part of the vehicle, which seems to be tailored exactly to fit the human form, with little or no allowance for outsizes.

Two Weber carburettors and a special cylinder head and manifold are fitted on the engine. A large diameter, unshrouded fan is mounted behind the radiator. A five-speed gearbox is also employed. The wheelbase is 6 ft 7½ in and the front and rear track is 3 ft 11½ in. A ground clearance of only 5·9 in has been adopted. The total weight of this vehicle is 1,020 lb.

The Beutler bodied Volkswagen has two doors. Its quarter lights are hinged at the front and each has a toggle latch at the rear. Exceptionally good all-round visibility is the outstanding feature of this vehicle. The windscreen pillars are only 2 in wide and the effective width of the centre pillar is 2⅛ in. All are separate welded-on components. The graceful lines of the roof are in conformity with the slenderness of the pillars.

Two Graber bodied Bentleys were displayed. One was a saloon and the other a drop-head model. These vehicles had an exceptionally low waist line, which no doubt will be appreciated by lady drivers who often feel swallowed up in large cars with high waists. In the saloon version shown, the exterior was finished in light grey, and dark grey hide was used for the trimming; the facia was of figured timber. The rear edge of the door glass is unframed so that the effective width of the centre pillar when the doors are closed is only 1⅛ in. In the saloon model, a three-piece, wrapped round rear window gives good visibility.

The passenger's seat squab is adjustable by turning a large hand-wheel at the base of the squab. This hand-wheel is mounted on a toothed wheel that meshes with an idler pinion which, in turn, meshes with an internally toothed quadrant. The whole mechanism is closed by a chromium plated cover plate. By incorporating the idler, the motion of the hand-wheel is reversed so that the squab moves backwards when the wheel is turned backwards and *vice versa*. If necessary, the squab can be laid right back on to the rear seat cushion.

An unusual feature of both models is a vertical chromium plated strip on the body panelling forward of the rear wheel. This strip forms a fillet in a step caused by a discontinuity in the section along the body side. At the front of the vehicle, a two-piece apron is fitted, and at the rear a single apron, profiled to fit the body contours, is mounted on the bumper irons. There is a 1 in gap between the rear panel and the apron.

STEAM ATMOSPHERE FURNACES

An Adaptable Birlec Unit

IT has been known for many years that electrical components such as laminations and shafts can be heated in a furnace in a steam atmosphere at about 500 to 550 deg C and that this treatment will produce a bluish oxide surface which is an electrical insulator. Steam atmospheres have also been employed in furnaces for the protection of the surfaces of brass and nickel silver during annealing. In recent years it has been found that high speed steel drills can also be heated in a steam atmosphere at a temperature of about 550 deg C with a resultant very pleasing blackish-blue surface which is actually an adherent skin of ferrosopheric oxide.

This oxide coating, in addition to being rust resisting, has been found to give added life to drills when carrying out certain operations but the main advantage is that these precision made components can be heat-treated without the need for a final grinding operation after the last secondary hardening treatment. A further and more recent application of the steam atmosphere furnace is for the treatment of ferrous sintered products after the actual sintering operation; it is claimed that greater hardness is obtained if the components are heated in a steam atmosphere after sintering.

As specialists in the manufacture of all classes of heat-treatment equipment, Birlec Limited, of Birmingham, have supplied furnaces in the past specially adapted for use with steam atmosphere, including both batch and continuous type equipments, but there seems to be a growing demand for a standard furnace for blueing such components as drills, electrical parts and other articles requiring a rust resisting finish. To meet this demand Birlec have developed a new range of vertical furnaces, see the accompanying illustration,

Birlec steam atmosphere

especially designed for use with a steam atmosphere and capable of operation at temperatures up to 700 deg C.

The furnace is of the vertical, cylindrical type and is built on orthodox lines with a brick-lined steel shell. An interior metal container covers the main brickwork so that the furnace bricks will not absorb the steam. A hand-operated cover or lid is supplied and the lifting equipment is designed so that no elaborate clamping methods are needed to ensure a gas-tight seal. Electrical insulators are mounted on the inner face of the metal container to carry the heating elements, an arrangement which ensures that heat is imparted direct to the charge by means of the air circulation system. A centrifugal fan and suitable baffles are provided to ensure absolute temperature uniformity throughout the charge space. Steam is admitted to the furnace chamber near the fan and the outlet is provided at the top of the chamber with drain valves at suitable points. The steam, which need only have a pressure of a few pounds, can be taken from the normal factory supply or, where this is not available, a separate, small and relatively cheap boiler can be provided.

The new standard furnace can be employed for heat-treatment applications other than steam atmosphere work where temperatures up to 700 deg C are required, such as the tempering of carbon steel tools and components, the annealing of copper and brass and the solution treatment of aluminium.

MINICARS

Three Continental Models

IT is generally conceded that in order to produce a small car at a competitive price, it must be made in very large quantities. However, the number of potential customers for the low powered type of vehicle that is capable of carrying only relatively light loads is limited. For this reason, cars of this type have not hitherto been produced on a large scale. The big manufacturers in this country have not ventured to introduce minicars; nor have they made an austerity vehicle capable of carrying loads similar to those of the more conventional light cars. Experience has shown that an austerity car when new costs as much or more than a second-hand conventional 8 or 10 h.p. car which, because of the better amenities that it affords, is more attractive to potential purchasers.

Messerschmitt

Very light weight motor cycles of the type commonly termed motor scooters are widely used in European countries for shopping purposes, taking children to school and other short journeys of this nature. They all suffer from the disadvantage that they offer inadequate protection from the weather. The Messerschmitt cabin scooter is a small three-wheeled vehicle for such journeys. Although it costs more than a motor cycle it is much less expensive than a car. It keeps its occupants warm, dry and clean, and there is space inside for carrying parcels or shopping baskets. Moreover, under icy conditions, it is safer than a two-wheeled vehicle. By resisting the temptation to compete on common ground with the more conventional cars, the manufacturers have been wise. This vehicle may well be entirely satisfactory for the duties for which it was designed, and probably will be attractive to those who cannot afford a second-hand car or who have inadequate garage space to house one.

The Messerschmitt three-wheeler is based on a tubular structure, to which the body panels are welded. As viewed from the side, the two side frames are each constructed of tubes welded together in the form of a triangle, the apex of which is immediately behind the rear seat. A strut joins the apex to the base. These triangular frames are set in planes at an angle from the vertical so that, as viewed from the front, they are of V-form. In the base of the V are two longitudinal tubes welded to two cross members, one at the extreme front end of the frame and another at the junction of the horizontal base member of each side frame with the strut to the apex. Another cross tube is welded between the apices. The part of the frame which extends behind the apex on each side carries the rear wheel, the single cylinder, air-cooled two-stroke engine, and gearbox. A mudguard is fitted over the wheel and on top of it is mounted a spare wheel. The floor is a shallow, inverted top-hat section that fits over the two central longitudinal members, which provide the necessary support for the two seats mounted in tandem.

The overall dimensions of the vehicle are: length 9 ft 3 in, width 4 ft, height 3 ft 11 in. It has a wheelbase of 6 ft 8 in and a front track of 3 ft. The ground clearance is $6\frac{1}{4}$ in. A petrol tank of 2·54 gallons capacity, which includes a third of a gallon reserve, is fitted. A mixture of 25 parts of petrol to one of oil is recommended. The weight of the vehicle is 385 lb.

The engine is made by Fichtel and Sachs. Its bore and stroke are 62 mm and 58 mm respectively and it has a swept volume of 174 cm^3. The compression ratio is 6·6 : 1, and the power developed is 9 b.h.p. at 5,250 r.p.m. A pedal operated, three-disc clutch is fitted, and four forward speeds only are obtainable with the gearbox; both units are of the motor cycle type.

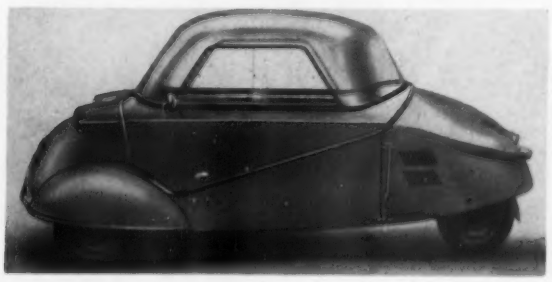
A hand lever, gear-shift control is mounted in a quadrant on one side of the dash. From the neutral position, it is moved backwards to select first speed, and the second, third and fourth speeds are engaged by successive forward motions of the lever. Downward changes to neutral are made by successive rearward movements of the control. In other words, it functions in the same way as a foot-operated control such as is used on most motor cycles. The primary reduction ratio is 2·12 : 1 and the four gear ratios are: top 0·86 : 1, third 1·24 : 1, second 1·85 : 1, and first 3·63 : 1. A roller chain transmits the drive to the rear wheel. Access is gained to the engine, transmission and rear suspension units by hinging upwards the whole of the rear end panel.

Other controls include a kick starter on the toeboard and a pedal for the mechanical brakes on all three wheels. A hand brake lever is also fitted. A handlebar type steering layout has been adopted and the windscreen wiper is actuated by a Bowden cable control actuated by a lever on the handlebar. A motor cycle type dip switch is also employed.

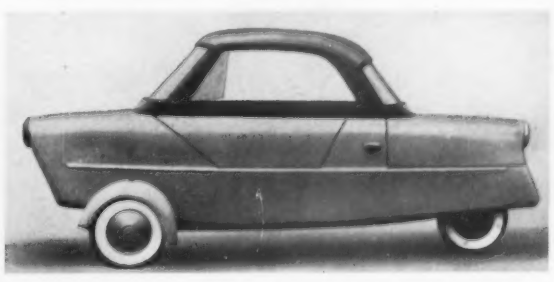
All three wheels are independently sprung on the Neimann principle, strap-type, rubber-band springs being employed. The tyres are 4·00 × 8. At the front, the pressure recommended is 11 lb/in^2 and at the rear 22 lb/in^2. A turning circle of 26 ft is obtained.

The electric equipment includes a Varta 6 volt battery of 6·9 amp-hr capacity. Bilux, 15/15 watt head lamps, and tail and stop lamps are fitted on the model shown, but on other models flashing direction indicators have been incorporated. Apparently the design is not finalized but may be changed as it becomes apparent what amenities are required on this new class of vehicle.

The hood is made of transparent plastics mounted on a frame. Sliding windows are fitted on each side and a Securit glass windscreen is incorporated. For access to the vehicle, the hood is hinged along one side; it is fitted with a lock. To facilitate entry, the front seat is mounted on two pairs of parallel links so that it can be moved to the rear. It is intended that the driver should sit down on the seat when it is in the rearward position and then pull himself forward. Coil type compression springs are mounted under the



The Messerschmitt three-wheeler vehicle is termed a cabin scooter and is intended for shopping and other short journeys



The front wheels of the Inter Kabinenroller swing forwards to retract so that it may be garaged in a confined space

seat pan to cushion the shock as the seat is swung into the forward position, and also to improve the ride. The rear end of the hood frame forms the lid of a small compartment for parcels. When the hood is closed the contents of this compartment are not visible from the outside.

Inter Kabinenroller

The Inter Kabinenroller is a somewhat more expensive three-wheeler. It has a gearbox giving three forward speeds and one reverse, and the 175 cm^3 motor is equipped with an electric starter. This vehicle is also a two-seater but, unlike the Messerschmitt, is of chassisless construction. The structure is formed by the body panels and suitable stiffening sections.

An Ydral single cylinder, two-stroke engine drives the single rear wheel. It develops 8 b.h.p. and its principal dimensions are: bore 62 mm and stroke 57·8 mm. Air cooling is effected by means of a blower.

All three wheels are equipped with 4·00 × 8 tyres, and they are fitted with Neimann type rubber springs. A somewhat unusual steering layout is employed. The steering wheel is not a complete circle but comprises two segments, one on each side of the hub, and is of a similar type to that employed on aircraft control columns. On the front end of the spindle on which the wheel is mounted is a sprocket over which is passed a roller chain. The ends of this chain are passed under two more sprockets, mounted at the level of the axle, and then out towards the steering levers on the front wheels. Cable connections are employed between the ends of the chain and the levers.

Another unusual feature of the vehicle is that the axle is divided at the centre in such a way that each half can be pivoted forwards. The steering geometry is such that when the axles are swung forwards the wheels maintain their true fore and aft alignment. This arrangement has been adopted so that the vehicle can be garaged in a garden shed. A lever type control for the lock that holds the axles in their normal running position is mounted in the centre of the floor at the front. Mechanically operated brakes are fitted to all three wheels. The drum diameter of those at the front is 5·9 in, while that of the rear one is 4·33 in.

The roof and part of the waist panel hinges to one side in a manner similar to that of the Messerschmitt vehicle. A Securit curved glass windscreen is fitted and the side and rear lights are of Plexiglass. The two seats are arranged in tandem. Access to the engine is gained by lifting the upper portion of the rear end panelling.

Unladen, the vehicle has an overall height of 4 ft 3 in. The other overall dimensions are: length 9 ft 4 in and width 4 ft 5 in. At the front, the track is 4 ft and the wheelbase is 6 ft 7 in. A ground clearance of 6½ in is obtained. The weight is 410 lb.

Access to the engine on the Isetta is obtained by removing a small panel

Isetta

The Isetta is a vehicle of completely different layout. It has four wheels, although the rear pair are close together. The only door is at the front, and its hinges are on the left-hand side. Two people can be accommodated on a bench seat at the front. An outstanding feature of this layout is that entry is extremely easy. It might be argued that if another vehicle were to be parked very close in front of it, the door could not be opened. However, this contingency is just as likely to arise with a conventional car, when others are parked close on each side. Behind the seat is a large shelf for parcels.

An Iso air-cooled, two-stroke engine is employed. It is carried on a three-point rubber mounting on the right-hand side of the vehicle immediately in front of the rear wheels. Two of the mountings are on the ends of a longitudinal bracket welded to an outrigger extension of the tubular cross member at the rear of the frame; the third is on the extension. The rear suspension and final drive units are overhung behind the rear cross member. Each of the two cylinders has a 48 mm bore, and the total swept volume is 236 cm^3. With a compression ratio of 6·5 : 1, the output is 9·5 b.h.p. at 4,500 r.p.m. The dry weight of the engine is 95 lb.

Cooling is effected by means of a centrifugal blower, and the air is directed round the cylinders by a pressed steel shroud. An electric starter is provided. A Dell'Orto carburettor is fitted and is served by gravity feed from the tank. Lubrication is effected by means of a variable stroke, plunger-type pump. A multi-plate, oil bath clutch transmits the drive to the gearbox. Four forward speeds and one reverse are obtainable. From the gearbox, the drive is transmitted to the back axle unit through a short tubular propeller shaft mounted transversely, with a flexible coupling at each end.

The frame is constructed from tubular components. Square-section side members are employed, and circular tubes form all the cross members except one, which is of channel-section. There are three main cross members, one at the front another at the rear and an intermediate one between the front suspension units. A subsidiary cross member, of channel section, is fitted behind the wheels and carries the brake master cylinder. It also supports the floor under the rear seat.

Quarter elliptic springs overhung at the back form the rear suspension. At the front, the wheels are mounted on a trailing link on each side. This link is formed by one arm of the bell crank lever, the other arm of which bears against the end of the compression spring mounted horizontally in a tubular housing. Friction type shock absorbers are employed at the front and telescopic at the rear.

A universal joint is incorporated at the lower end of the steering column and the upper end is supported by a casting mounted below the waist rail on the door in such a way that the column swings forward with the door

There are two seats in tandem in the Messerschmitt vehicle; the front one can be moved rearwards to facilitate entry

On the Isetta, the universally jointed steering column swings out with the door

A three-point rubber mounting is provided for the engine on one side of the Isetta chassis

On the Isetta, the hood can be folded and the triangular panels on each side at the front can be opened

when it is opened. The casting also serves as an instrument panel. It accommodates a speedometer and warning lamps for the flashing direction indicators and dynamo. Hydraulic brakes, with 7·1 in diameter drums, are fitted on all four wheels. The tyres are 4·50 by 10, and the pressure recommended is 10-12 lb/in^2.

At the front, the track is 3 ft 11 in and at the rear it is 1 ft 7$\frac{3}{4}$ in. The overall dimensions are: length 7 ft 4$\frac{3}{4}$ in, width 4 ft 4$\frac{3}{4}$ in, height 4 ft 4 in. A fuel tank of 2·9 gallons capacity is fitted, and it has a reserve of $\frac{1}{2}$ gallon. The kerb weight of the vehicle is 725 lb.

The body is supported on a tubular framework. One hoop forms the door opening and a second, behind the seat squab, supports the rear part of the canopy. Between the two is a canvas hood that can be folded back, cabriolet fashion. A head rail is attached to the front edge of this hood. Welded to each end of this rail are radius rods pivoted on the cant rail midway between the two body hoops. Two intermediate cross members of light section help to maintain the shape of this hood. A top-hat section waist rail is welded to the hoops and a separate portion of it is welded to the door. Safety glass is employed for the windscreen and the remainder of the windows are of transparent plastics. A triangular ventilation panel is fitted on each side at the front. These two are the only panels which can be opened.

An extremely simple body panel arrangement has been adopted. Apart from the door, there are three main pieces below the waist rail, one on each side and another at the back. The joints are joggled. Above the waist, sheet steel cappings are welded to the tubular members. Faced millboard is used for the interior trim panels on each side. A spare wheel is stowed behind the seat squab, and both the squab and cushion are formed by rubber strips in tension stretched over a tubular frame.

RECENT PUBLICATIONS

The Motor Industry of Great Britain 1953

London: THE SOCIETY OF MOTOR MANUFACTURERS AND TRADERS LTD., Statistical Department, 148, Piccadilly, London, W.1. 1953. 7×9$\frac{1}{2}$. 324 pp. Price £1 10s to Members, £2 2s to non-Members.

The seventh post-war edition of this book issued by the Statistical Department of the Society of Motor Manufacturers and Traders Ltd. follows the layout and general pattern of its predecessors. Thus, it provides the necessary continuity of statistics from which the progress of the industry may be followed. The many pages of figures and graphs show the achievements during the year 1952 of British and foreign industry.

After the title pages, contents, foreword and preface, there are four chapters. The first gives production figures of home producers as well as of foreign manufacturers; the second tabulates registrations of motor vehicles at home and overseas; the third enumerates exports and the fourth is entitled "Miscellaneous Information." In this last chapter, a useful summary of motor vehicle construction and use regulations overseas is given for 45 territories. This, together with the regulations for some 52 territories which were given in the previous edition, covers the main markets of the world. The scope of the tables has been widened to include additional details relating to public service vehicles.

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Diesel Engine Design

By T. D. Walshaw, B.Sc.(Eng.), D.L.C. (Eng.), A.M.I.Mech.E., A.M.I.P.E.

London: GEORGE NEWNES LTD., Tower House, Southampton Street, Strand, London, W.C.2. 1953. 5$\frac{1}{2}$×8$\frac{1}{4}$. 415 pp. Price 35s.

This is the second edition of *Diesel Engine Design*, which was first published in 1949, and in its preparation the opportunity has been taken to incorporate descriptions and illustrations of new designs. In addition, changes have been made to bring up-to-date the sectional views of engines that have undergone important modifications since the first edition was published. Other illustrations, of engine parts and accessories, have been replaced by the most modern designs. These include new starting devices and turbo-blowers.

The work is based on the author's experience as a designer, supplemented by the close study of the best British and American practice. It begins with a chapter on thermo dynamic principles, followed by another on combustion in the engine cylinders. Chapters 3 and 4 are devoted to descriptions of engine types and sizes respectively, and they are followed by a chapter on general considerations of design. In the remainder of the book, detail features such as cylinder liners, pistons, connecting rods and flywheels are discussed, and it includes chapters on balancing and supercharging.

NICKEL-CHROME PLATING

An Outstanding Plant at the Works of Vauxhall Motors Ltd.

AN automatic nickel-chrome plating plant that is without parallel in any motor car plant in this country or in Europe, has recently been installed at the Luton Works of Vauxhall Motors Ltd. This new plant comprises 22 pairs of process tanks arranged in two parallel rows. It is 30 ft wide and has a total length of 180 ft. It fully mechanizes 22 dipping processes that were formerly done partly by hand and partly with the assistance of various forms of lifting tackle. In addition to flash copper plating, nickel and chromium plating, the process carried out in the installation includes cleaning by dip, spray wash and electrolytic cleaning methods. The current available for the plating and electrolytic cleaning operations totals 64,000 amps.

The principal feature of the plant is the process conveyor system, which carries frame loads of components automatically through the complete sequence of dipping operations. An auxiliary conveyor system feeds the main plant with loaded frames and also delivers finish plated parts to the inspection bay and thence to the assembly area. At present the components that are processed in the plant include radiator grille bars, door division channels, bonnet flutes and bumper over-riders. A total of 34 ft^2 can be produced every 3½ minutes and 72 frame loads of components are delivered per hour. Major polishing operations are not required on the components processed in the plant, which is run by only eight men.

Prior to the processing on the automatic plant, the components are given an acid copper - plating operation and are then polished. Practically the whole of the polishing after acid-copper plating is carried out on completely automatic machines developed by the Company. After they have been polished the components are loaded into pallets ready for transfer to the adjacent plating plant by fork trucks.

The plated parts are delivered to the loading bay shown in Fig. 1 where they are loaded on to suspenders coated with an insulating plastic to conserve plated solution. The suspenders are carried on an auxiliary overhead chain-link conveyor to the loading stations for the processing plant. As was stated earlier the plant comprises two parallel rows of 22 tanks. These two rows are served by a common conveyor system running between them. Both process rows can be used simultaneously or, if so desired, one can be run while the other remains idle.

At the load end of the plant, the auxiliary conveyor is fitted with four locking gates to hold four suspenders in position for transfer to the process conveyor. This arrangement is shown in Fig. 2. Transfer of the suspenders from the auxiliary conveyor to the process conveyor is effected by means of a special air hoist on a wheeled framework, see Fig. 3. With both processing rows of tanks in use, two suspenders are transferred at the loading station for one row and two at the loading station for the other row.

The main conveyor system comprises a twin-strand chain conveyor running parallel with and between the processing tanks and carrying 120 beams, or flight bars, which extend over the tops of the tanks at each side. These flight bars are equally spaced. They are kept in position by deeply-flared U-shaped attachment plates fastened to the twin-strand conveyor. On the forward run the twin-strand conveyor is at such a height as to carry the flight bars just clear of the tops of the processing tanks, see Fig. 4. It is, of course, necessary to raise the flight bars to allow the work to be transferred from one processing tank to the next, therefore the flight bars merely rest in the U-shaped attachment plates of the twin-strand conveyor. During the forward run the flight bars rest on and slide along delta track.

Probably the most interesting feature of this conveyor system is the method employed for raising suspended loads of components from one tank and transferring them and lowering them into the next processing tank. This is effected by means of transfer towers between the tanks and lying between the twin-strand chain conveyor. One of these towers can be seen in Fig. 4, which also shows in the foreground, flight bars approaching the position for raising, and in the background other flight bars ready for lowering.

Each transfer tower is fitted with a wheeled carriage. When the flight bar reaches the transfer station it contacts a limit switch to switch on the lifting motor, which drives a sprocket wheel. A roller chain, attached to the wheeled carriage at one end and to a heavy counterweight at the other, passes over the sprocket wheel to haul the carriage and the flight bar up the tower. At the desired height of lift the motor is automatically cut out.

When the flight bar has been raised to the required height it is automatically moved forward a distance of 3 ft 7 in; this distance is standard throughout the

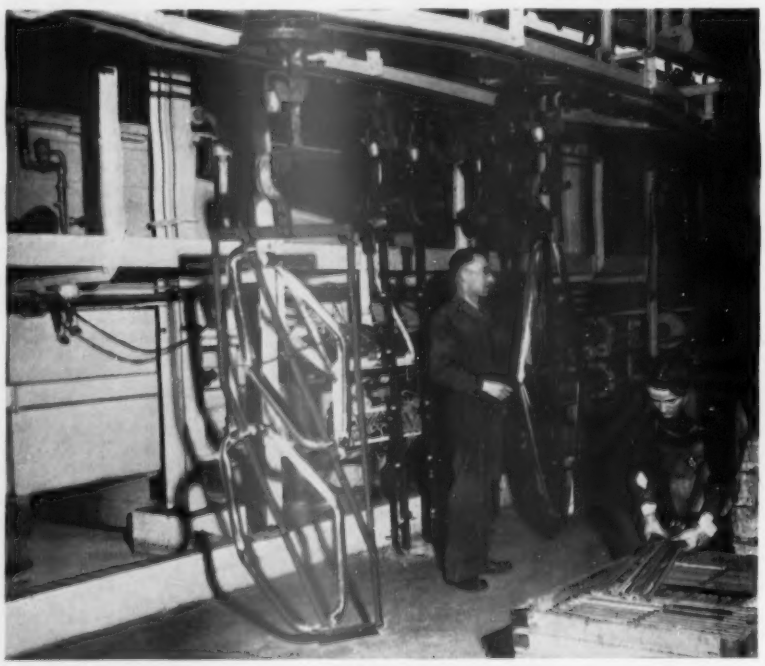


Fig. 1. Loading the auxiliary conveyor for transfer of components to the loading station of the plating plant

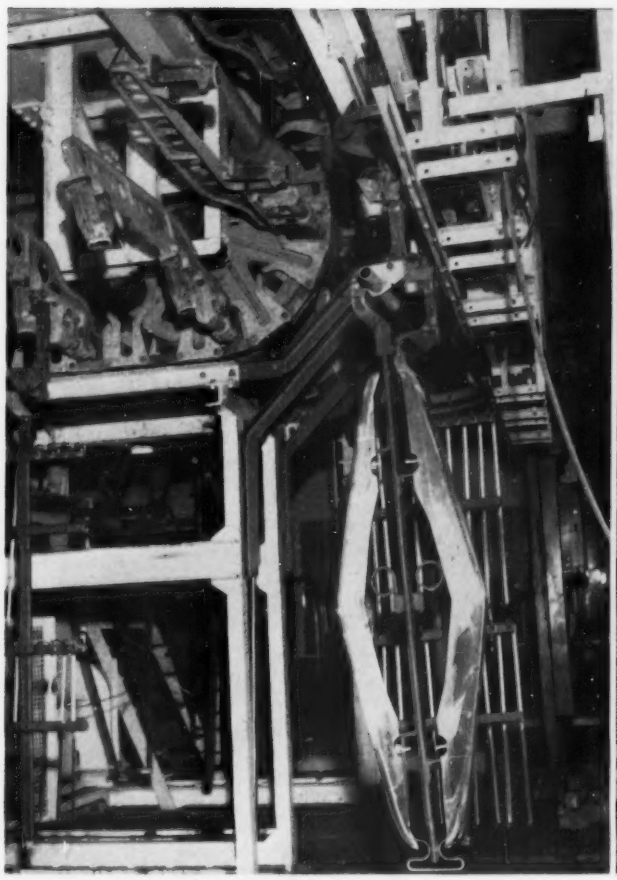


Fig. 2. Suspenders on the auxiliary conveyor locked in position ready for transfer to the main conveyor

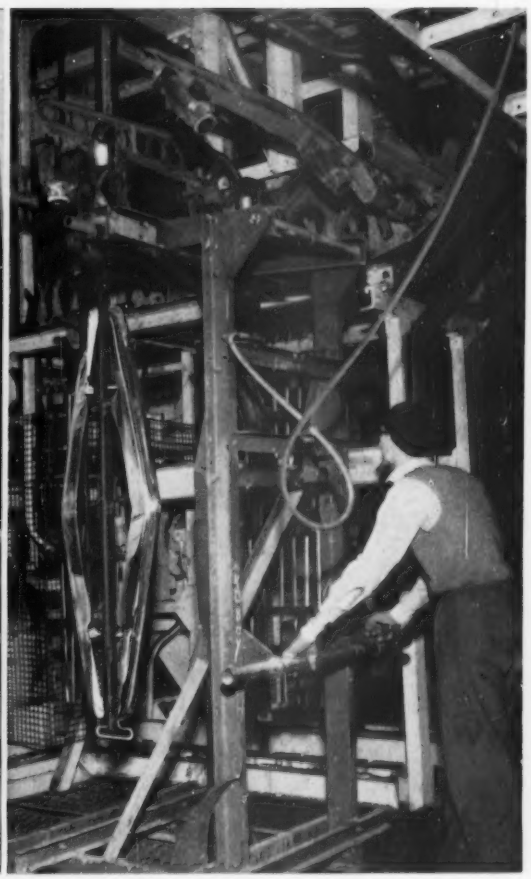


Fig. 3. Loading the main conveyor. An air hoist lifts the suspenders into cone and socket connections on the flight bars

run, and is sufficient to clear the lips of adjacent tanks to allow the flight bar to be lowered cleanly into the next tank. This movement is effected by means of a push bar attached to a rack, see Fig. 5. A pinion driven by its own motor engages in the teeth of the rack and so pushes the flight bar the required distance. Where successive tanks require equal immersion times, it is possible to effect simultaneous transfer of two flight bars. When the flight bar is in position for lowering into the next tank, the wheel carriage motor starts in reverse and the carriage runs down the tower to return the flight bar to the continuously moving chain conveyor.

After the processing is completed, the plated components, still on their suspenders, are transferred to the auxiliary conveyor for transfer to the inspection bay. After the flight bars have been unloaded, the main conveyor carries the flight bars upwards and then back to the loading end of the plant. The flight bars are upside down for the return journey with skids fitted to run on small rollers. The return strand is shown in Fig. 6.

The processing sequence may be regarded as being carried out in four stages: preparation, copper plating, nickel plating and chromium plating. Six tanks are used for the preparation processes, five for the copper plating, six for the nickel plating and five for the chromium plating. The actual sequence follows.

In the first tank the components are power spray cleaned in an alkali solution at 180 deg F in a processing time of 2 min 40 sec. Power spray cleaning is again carried out in the second tank. Once again an alkali solution is used at 180 deg F but the processing time is only one minute. Electrolytic cleaning methods are used in the third and fourth tanks. A solution of sodium cyanide and sodium carbonate is used in each tank. In the third tank the solution is maintained at 180 deg F and the components are given a cathodic alkali clean lasting 2 min 40 sec. The polarity is reversed in the fourth tank to give an anodic alkali clean. Once again the processing time is 2 min 40 sec but the solution is maintained at room temperature. To complete the preparatory stages, water cleaning at room temperature is carried out in the fifth and sixth tanks. In each case, passage through the tank takes one minute, but whereas the fifth tank merely gives a water swill, the sixth gives both swill and spray cleaning.

To begin the copper plating sequence, the work is given a sulphur acid dip for one minute at room temperature in the seventh tank. This is followed by a water spray and dip clean for one minute at room temperature in the eighth tank. The actual copper plating, by the cyanide flash method, is carried out in the ninth tank. The solution is mainly copper cyanide maintained at 145 deg F. Passage through this tank takes 10 minutes to give a minimum deposit thickness of 0·0002 in. Cleaning by water swill in the tenth tank and by water swill and spray in the eleventh complete the copper plating sequence. For each of these operations the water is maintained at room temperature and the processing time is one minute.

The nickel sequence starts at the twelfth tank with a sulphuric acid dip for one minute in a solution at room temperature, followed by a one minute water swill and spray at room temperature in the thirteenth tank. At this stage the components are ready for bright nickel plating. A special nickel solution is used at 130 deg F. A minimum deposit of 0·001 in is specified.

To obtain this a processing time of 60 minutes is required, which necessitates a tank more than 48 ft long. Incidentally each of the bright nickel

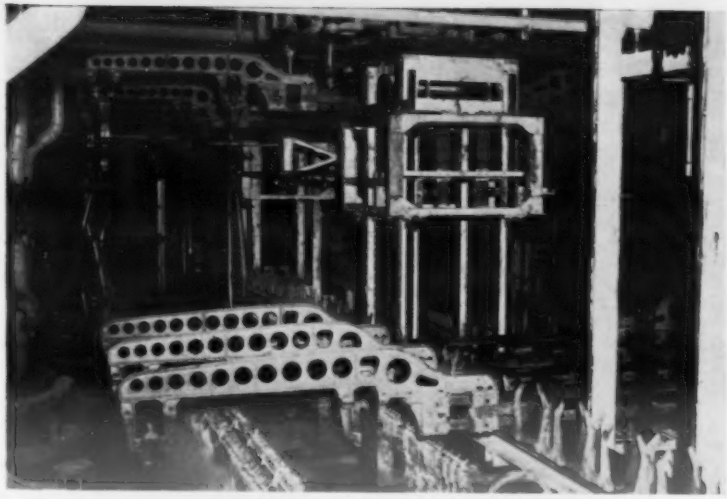


Fig. 4. A transfer station on the plating plant, showing one of the transfer towers and flight bars at transfer height in the background

Fig. 5. The rack and pinion arrangement for moving the work forward from one tank to the next

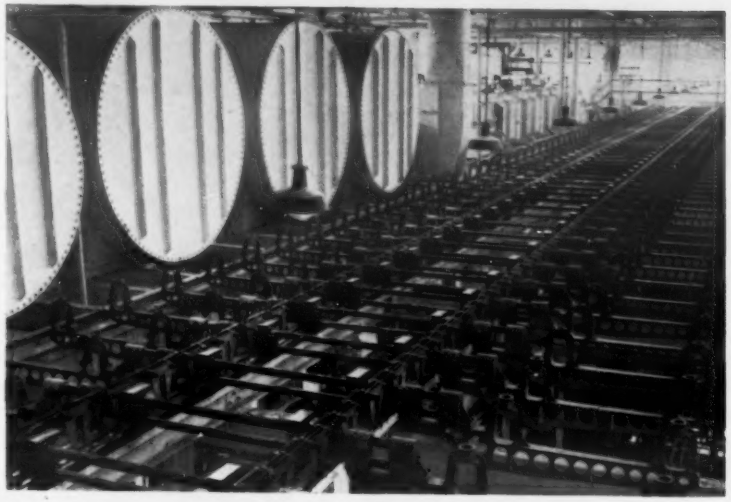


Fig. 6. The return strands of the flight bar conveyor. The solution storage tanks are also shown

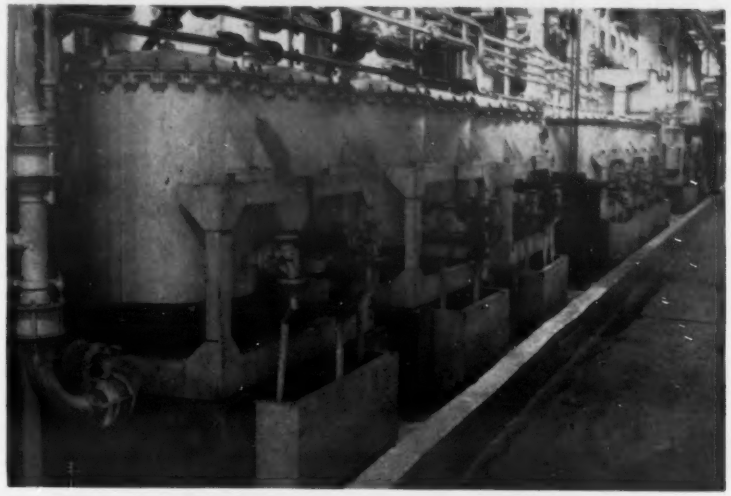


Fig. 7. The pumping and filtration plant. Rubber-lined, motor-driven pumps are used to feed the process tanks

plating tanks has two mechanical agitation units, whereas agitation of the solution in the other tanks is effected by means of compressed air. To complete the nickel plating sequence, three cleaning operations, one by water swill and two by water swill and spray, are carried out in the fifteenth, sixteenth and seventeenth tanks. In each case the process time is one minute and the water is at room temperature. On leaving the seventeenth tank and before being transferred to the chromium plating sequence, the work is lowered into a bay between Nos. 17 and 18 tanks for inspection.

From the inspection bay the work passes direct to the chromium plating tank. The solution is mainly chromic acid and is maintained at 130 deg F. A minimum deposit thickness of 0·00001 in is specified, and the process time is one minute. Four cleaning operations in water complete the processing. Each of these takes one minute, and the temperatures in sequence are: 140 deg F, room, room and 170 deg F.

All the tanks are rubber lined, except for the two chromium plating tanks which are lined with a layer of antimonial lead weighing six pounds per square foot with a second layer of P.V.C. Those tanks that carry heated solutions are also provided with outer jackets that house thermostatically-controlled heating coils with hot water as the heating medium.

Four cylindrical rubber lined tanks are used to store 15,000 gallons of bright nickel solution, while the copper solution is stored in a similar tank 12 ft 6 in long by 7 ft 6 in diameter. These solutions are passed to the process tanks by means of rubber-lined, motor-driven pumps. The copper solution passes through filters which can deal with 800 gallons of solution per hour. These filters ensure that the solution is mechanically clean. The pumping and filtration plant is shown in Fig. 7.

For bright nickel plating it is necessary to ensure that the solution is both mechanically and chemically clean. To ensure chemical cleanness, the nickel solution system incorporates a small electroplating tank through which the continuously circulating solution passes before going to the mechanical filters en route to the processing tanks. This tank is arranged for low-current density plating for removing solution contaminants. The mechanical filters deal with 6,000 gallons of nickel solution per hour.

Current for the electrolytic processes is taken from the mains and transformed by means of oil-immersed metal plate type rectifiers. There are 24 rectifiers, 10 of them motorized to give infinitely variable control. The current is fed to the process tanks through aluminium and copper strip bus bars, while the current for the plating operations is passed to the components via the flight bars which pick up current from the section of delta track running beside the chain links of the main conveyor. The entire electrolytic installation is controlled at one point of the central control panel. There are separate control points for the conveyor systems and the pumping and filtration equipment.

Every component passing through the plant is given a visual inspection before it is transferred to the assembly section. To ensure that product quality is maintained at the specified high standard, there are frequent and periodic checks on the solution, with further periodic tests to ensure that the specified minimum thicknesses are maintained at the flash copper plating, the bright nickel plating and the chromium plating operations. Regular tests of the salt water type are also carried out to check the durability of the plating.

ZINC ALLOY DIE-CASTINGS

A New Certification Mark Scheme to Encourage the Maintenance of Good Quality

BECAUSE of the difficult position with regard to material supplies in the immediate post-war period, sub-standard zinc alloys were sometimes accepted for die-casting. As a result of unfortunate experience with these poor quality products, zinc alloy generally tended to fall into disrepute, when in fact there was no justification for drawing such adverse conclusions regarding the suitability of the properly alloyed metal for load carrying components. Provided certain harmful impurities, notably lead, tin and cadmium are not present, alloys can be prepared which have an ultimate tensile strength of 23·4 ton/in^2, falling to 20·8 ton/in^2 after twelve months normal ageing, or to 17·7 ton/in^2 after ten days accelerated ageing treatment at 95 deg C.

The Zinc Alloy Die-Casters Association, to save customers from being disappointed with the results obtained with these components, have worked in conjunction with the British Standards Institution to draw up a certification mark scheme for zinc alloy die-casting. Castings made by manufacturers licensed under the scheme will carry the Kite-mark, B.S.1004, and the die-caster's name, trade mark or B.S.I. licence number. If this is impossible, for instance, because the castings are too small to be marked individually, they will be supplied in specially labelled boxes.

B.S.1004:1942 lays down specifications and tests for ingots and finished castings made from Alloy A and Alloy B. The only difference in composition between these two alloys is in their respective copper content. Alloy A is virtually copper free, while Alloy B normally contains 1 per cent copper. To appreciate the difference between the properties of the alloys, it is necessary to know some details of their development.

The first zinc alloy based on high purity zinc, and thus virtually immune from inter-crystalline corrosion, contained approximately 3 per cent copper in addition to 4 per cent aluminium. This alloy was easy to cast, had high tensile and impact strengths in the as-cast state, and was widely applied as a general purpose alloy for die-casting. On ageing, it exhibited an appreciable dimensional increase and loss of impact strength. These properties were found to be the result of phase change due to the presence of copper. The change is considerably accelerated with relatively small elevations of temperature, stable conditions being reached within a few days if the temperature is maintained at 100 deg C.

As the copper content was reduced, it was found that the stability of the alloys increased. The 1 per cent alloy exhibits only slight growth and no loss of impact strength after five years of normal temperature ageing although, like the 3 per cent alloy, it is unstable at elevated temperatures. The copper-free metal, Alloy A, is not subject to this effect. With these lower copper contents, the tensile strength and hardness of the alloys are somewhat less, but the differences are unimportant for many applications. Castability is also somewhat reduced with lower copper content, but improved die-casting techniques have overcome any troubles that were formerly experienced in this respect.

The fact that Alloy A retains its mechanical properties to a marked degree at elevated temperatures permits a stabilizing heat treatment to be adopted. Figures given in the standard booklet show that the initial shrinkage of Alloy A, although very small in itself, represents by far the major dimensional change in this alloy. Thus, when the initial shrinkage is fully developed by means of a stabilizing treatment at 100 deg C, the subsequent dimensional stability is enhanced. Alloy B does not lend itself to such treatment, as it would thereby suffer considerable loss of impact strength.

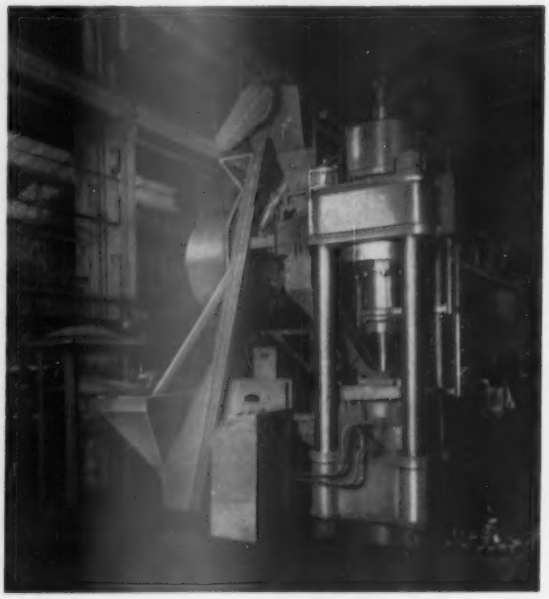
INDEXES AND BINDING CASES

Indexes and binding cases for volume XLIII (January to December, 1953) of the "Automobile Engineer" are now ready. The price of the index is 7½d., and the binding case together with index is 6s. 5d., both post free. Alternatively, readers' copies can be bound in publishers' binding cases at an inclusive cost of 18s. 10d. including return postage. Remittance with order should be sent to the publishing department, Dorset House, Stamford Street, London, S.E.1.

SWARF RECOVERY

A Hydraulic Baling Press for Briquetting Cast Iron Machinings

ALTHOUGH a good deal of swarf recovery is carried out in most well organized engineering factories, there has been a tendency to concentrate on the reclamation of the more expensive materials. One of the greatest sources of swarf, cast iron, has been relatively disregarded. There are three reasons for this. In the first place cast iron is a relatively cheap material, but in many engineering shops the volume of cast iron swarf will be great enough to make recovery well worth while. Secondly, it is a material that is not easily processed in conventional baling equipment. Finally, because of furnace charging difficulties, the recovery of cast iron swarf has not been economical owing to the losses due to fine and small machinings being burnt and carried away with the flue gases before getting down to the melting area.



Fielding and Platt hydraulic briquetting press

To meet the need for equipment suitable for dealing with cast iron and other materials for which conventional equipment is not satisfactory, Fielding and Platt, Ltd., Gloucester, have developed a 400 tons hydraulic briquetting press of revolutionary design. It is shown in the accompanying illustration. This machine is fully automatic in operation, and is capable of converting small cast iron machinings into high density briquettes at a constant and rapid production rate. Neither bonding nor sintering is required in the process, and the briquettes can be conveniently handled and conveyed direct from the press to the cupola or furnace for re-melting.

The press is of the vertical four-column type. It is self-contained and complete with its own hydraulic pumping unit using oil as the pressure medium. Although it has been designed particularly for dealing with cast iron swarf, with certain modifications it can be adapted for the production of briquettes from small non-ferrous machinings, such as brass or aluminium. The principal characteristics are:

Power of main ram	400 tons
Stroke of main ram	15 in
Specific pressure on material	48 ton/in^2
Total time cycle (approx.)	11·5 sec
Weight of briquettes	4 to 6 lb
Average density	85 per cent
Briquettes per hour	300-340
Tonnage per hour	0·7-0·9

Press control is by electrical push buttons through D.C. solenoid-operated valves, which are of the balanced type for operating with oil. The complete control equipment is arranged for automatic operation. Pressure is supplied from two high-speed radial pumps, one driven by an 80 h.p. and the other by a 50 h.p. motor.

Swarf is loaded into a bunker of approximately one ton capacity. For the production of briquettes weighing four to six pounds each this represents storage capacity for about one hour's work. From the bunker swarf pours on to a vibrating screen that will reject large pieces of metal or other unsuitable material. Rejections are carried away down a small chute fitted at right angles to the direction of material flow.

The screened material passes into a reservoir at the foot of an elevator, whence it is carried to a small hopper at the top of the machine on flights attached to the elevator chain. A vibration attached to the hopper ensures a continuous supply of swarf into the dispenser, which is a device for measuring by weight the correct amount of swarf to make one briquette. After it has received the correct amount of material, the dispenser is tilted by air cylinders to discharge its load down a chute leading to the briquetting mould. As soon as the swarf is discharged, the dispenser is automatically returned to the filling position. The action of the dispenser is not only fully automatic, but it is also interlocked with the pressing cycle of the machine. Should the elevator supply swarf faster than the machine can deal with it, surplus material returns to the reservoir through an overflow pipe fitted above the dispenser.

When the measured quantity of material has passed into the briquette mould, the main ram mandrel comes down and presses it. The pressure is then locked in the main cylinder while the mould is lifted by four small lifting rams and the briquette is stripped from the mould. To release the briquette completely, the main ram is returned to the up or filling position.

PREVENTION OF RUST AND CORROSION

AS a means of protecting metal equipment from the deleterious fumes likely to be present in the atmosphere in motor works, test houses or garages, Detel Products Ltd., of South Ruislip, has developed a special coating medium completely resistant to acids, alkalis, alcohol, mineral oil and petrol. It consists of chlorinated rubber and synthetic resins dissolved in a mixture of high-flash aromatic hydrocarbons in which is ground a suitable pigment. On almost any surface it will form a tenacious film that is neither porous nor inflammable. It is best applied by brush but in certain circumstances spraying or dipping can be employed.

For protecting such equipment as girders, pipes, tanks or petrol pumps a special Detel undercoating gives a film containing about 96 per cent of finely divided metallic zinc. When dry, any good oil-bound or synthetic paint can be applied without further treatment.

Detel can also be applied to walls and floors, producing a smooth surface that can be washed with soap and water. It is particularly suitable for dust-proofing concrete floors, since the lime in the concrete has no ill-effect on the film. In service, worn patches can be readily reconditioned. (2052)

BUSES AND COACHES

Recent Continental Developments

TOURISTS provide Switzerland with much of its overseas currency and trade, and an entire industry is devoted to meeting the requirements of visitors to the country. It is, therefore, not surprising that Swiss touring coaches are among the most luxurious built in the world to-day, and differ greatly from similar products of other countries, both as regards equipment and structural design. City buses, too, are built to different standards in Switzerland, where rather more attention is paid in the construction of such vehicles, to the ability of the chassis and bodywork to support an occasional overload amounting to over 100 per cent of the unladen weight. High initial and running costs for both passenger and goods vehicles require long term amortization, and so Swiss built bodies are devised throughout for an unusually long effective life. There are few examples in Switzerland of passenger or goods vehicles with the equivalent of a British composite body, almost all, in fact, being entirely of steel construction, although many utilize light alloy components, as well as timber floors. Although the home market for coaches and buses is extremely small, absorbing only 156 vehicles last year, and 130 in 1952, the Swiss bodybuilders' work is thorough and their methods are modern. Typical, both as regards styling and structure, is the small Lauber chassisless 14-seat coach built by Carrosserie Lauber & Fils S.A., of Nyon. This has been marketed since 1951, and is powered by a Chevrolet six-cylinder 106 b.h.p. petrol engine. The vehicle is 19 ft 8 in long, 6 ft. 8 in wide, and 7 ft 9 in high, and weighs 2 tons 15 cwt unladen. Its wheelbase is 10 ft 5 in, and the front and rear overhang are 3 ft 7 in and 5 ft 8 in respectively.

In the Saurer postal coach with Eggli bodywork, the seats move bodily sideways into the gangway. There is a central ventilation duct in the fully glazed roof

The underframe, like the entire structure, is built up of rectangular section steel tubing, 50 mm × 30 mm × 2 mm. Two parallel longitudinal members running the entire length of the vehicle support the floor and the cross bearers on which the body is built up. Underneath the longitudinals a second structure is arranged to support the wheels and running components. It consists of a pair of secondary longitudinals cranked to clear the axles and to provide attachment points for the front and rear hanger brackets of both front and rear semi-elliptic springs. This provides ample longitudinal rigidity, and torsional rigidity is provided by a cruciform structure, composed of the same tubing, running between the rear hanger brackets of the front springs and the front hanger

The 39-seat, luxury body on this A.E.C. Regal Mark IV chassis was built by Rameier and Jenzer, Berne, and is an outstanding example of Swiss styling. The body is of steel construction throughout

Equipped with a rear-mounted Henschel engine, the Setra coach is a chassisless structure with an exceptionally low unladen weight

brackets of the rear springs, and reinforced by a large circular gusset welded on top of the centre of the cruciform.

On top of the underframe, five tubular cross bearers are welded into position at pillar stations. With the addition of a simple triangular mild steel gusset of 1·5 mm gauge, the pillars are then welded directly to the ends of the cross bearers. The pillars themselves are 40 mm × 30 mm × 2 mm in dimension, and the upper ends are welded to the cant rail, which carries 30 mm × 30 mm × 2 mm roof sticks. The roof is divided into three sections, the entire centre being occupied by a double-skinned ventilation duct, while the outer panels, including the cant area, are completely glazed.

The waist rail is outside the pillars, and comprises a simple angle-section attached to the pillars by pop rivets with the flange pointing outward, to form a surface on which the single-piece Aluman light alloy panels are attached by bolts. A polished light alloy moulding of semi-circular section covers the rail and bolts. Additional panel fixing bolts are concealed beneath the decorative mouldings running along the sides and bottom of the body. The centre section of the roof is framed in tube 30 mm × 16 mm × 2 mm and the inner and outer panels overlap the edge of the framing and are also riveted to the roof sticks. The cant rail is of similar section to the main pillars, is welded between the pillars and covered by polished mouldings.

Similar principles are found in most of the Swiss-built bodies, although the majority are mounted on conventional chassis. A good example of the line achieved by these methods is the A.E.C. Regal Mk. IV with 39-seat bodywork by Ramseier and Jenzer. With the exception of the sliding centre section, the entire roof is glazed, and the main side windows are each 4 ft 10 in wide and 2 ft 3 in high. The door on the left of the body has a maximum width of 3 ft 2 in, but is cut away over the front wheel arch. To permit maximum ease of entry through the entrance behind them, the two front seats are hinged at the front, so that they may be swung forward. The sliding roof is opened by a Scintilla electric motor, and the rearmost section may be lifted up to form an extractor.

Channel and box section members comprise the framing of this chassisless, Ikarus rear-engined coach from Hungary which has hinged double doors

Most of the Swiss coach operators are reconsidering the question of the sliding or folding roof, because of the difficulties associated with draught, and of locking the roof when it is open, in view of the high speeds now attained by vehicles of this type. There has therefore been a distinct trend towards the provision of forced draught ventilation through a duct in the centre of the roof which takes in air through an intake above the centre of the windscreens.

Two new Swiss postal coaches, one a forward-engine bonneted Saurer with bodywork by Eggli, and the other an experimental underfloor - engined F.B.W. with Gangloff bodywork are provided with equipment of this type. An electrically-operated fan is located behind the air intake, and may be used when the vehicle is stationary; otherwise incoming air passes through the 2 ft 4 in wide duct and is diffused through outlets along its length. The duct also carries all the interior lighting fittings, the radio loudspeakers and bell pushes so that the necessity of wiring the body sides for these services is obviated. The rest of the roof, from the duct to the cant rail on each side, is glazed with glare-reducing glass, some of the panels being moulded to intricate curves, so as to provide unimpaired visibility in all directions.

Another popular fitting in Swiss coaches is the spring-loaded seat frame which, on release of the appropriate control, moves bodily out into the gangway. In some cases this reduces the gangway width from 12 in to 3 in and in others, because of arm rests on the gangway sides of the seats, the seats on opposite sides of the gangway actually meet. This is the case in the Eggli vehicle, in which the dual seats move bodily sideways under the control of a lever between the seat backs. Lauber coaches are equipped with a different type of seat, in which the inner half moves approximately 3 in and the outer one approximately 1½ in. This differential movement greatly improves the elbow room available for the passenger seated on the gangway side.

The Lauber patent seat is arranged to provide differential sideways movement of the individual halves of the seat to provide improved elbow-room

Reclining seats are not as widely employed as might be expected. Nevertheless, an interesting example of this type of equipment is the new Kâssbohrer-Setra chassisless 32-seater. This German chassisless rear - engined vehicle is equipped with individual seats which can be adjusted to one of three positions. The seat backs are hinged at the bottom, and a rod running inside the left hand arm rest controls the movement of the back. At its forward end, this rod carries a piston that fits inside a cylinder concealed in the arm rest. A coil spring between the closed rear end of the cylinder and the piston provides the necessary loading to assist the back to return to its normal upright position.

The construction of the Setra is interesting, in that it utilizes the elements of the backbone type of chassis in a structure composed entirely of square-section tubing. The underframe consists of a narrow box, framed in square-section tubing and panelled in light gauge steel sheet. Light cross bearers are welded above and below this "backbone" and carry the pillars

Straightforward, angular lines are found in most Swiss city buses, of which this underfloor-engined Mowag is a typical example

at their outer ends. The radiator is mounted at the front of the structure and the engine at the rear inside a forked extension of the backbone framing. Cooling liquid and all controls run through the backbone from the front to the rear of the vehicle. Ducts formed between the inner and outer panelling of the body sides are used to carry warm air from the front of the vehicle to the interior for heating purposes. Another unique feature of this design is that the underside of the underframe is panelled so that the space between the two cross bearers may be utilized for baggage.

Another unusual design is the Hungarian Ikarus rear-engined coach, which is also an integral structure. This vehicle has double hinged doors in the centre of the body which provide an effective entrance width of 4 ft 2 in. The steps leading to the interior are 15½ in, 10½ in and 10½ in respectively. These figures are almost identical to those obtained in the Mowag underfloor-engined bus, which is equipped with longitudinal seats running along both sides of the body for approximately 45 passengers, with standing room for an equal number. Like all Swiss city buses the bodywork of this vehicle is straightforward in the extreme, the pillars all being perfectly straight. This gives a practical, if angular, appearance to the bus. Large windows ensure that passengers, whether seated or standing, can easily discern where they are *en route*. A new F.B.W. underfloor-engined bus for Zürich is equipped with four doors. Two jack-knife doors at the rear constitute the entrance, which is 4 ft 9 in wide, while single jack-knife doors at the centre and front, each 2 ft 9 in wide, are the exits. Bodywork in this case is also based on steel square section tubing.

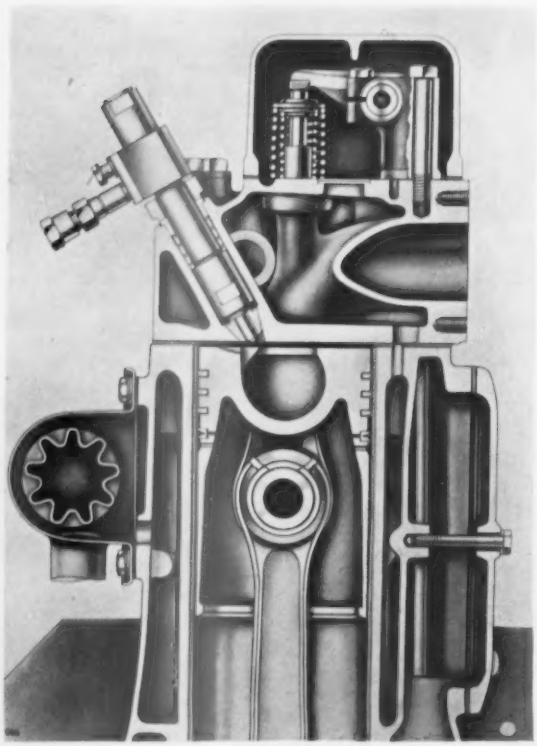
M.A.N. DIESEL

An Interesting New Direct-Injection Engine

A DIRECT-INJECTION engine with remarkably good characteristics has recently been developed by Maschinenfabrik Augsburg-Nürnberg A.G. It is designated the 630 L 1 and is intended for use in M.A.N. 6-ton trucks. A cross-section through a cylinder is shown in the accompanying illustration. This is a six-cylinder engine of 112 mm bore and 140 mm stroke and of 8,276 cm³ capacity. It develops 130 h.p. at 2,000 r.p.m. with a maximum torque of 376 ft-lb.

The direct-injection principle has been employed for all M.A.N. engines because of the low fuel consumption and excellent cold starting characteristics that go with this principle. Nevertheless, it has been clearly realized that such engines have, hitherto, also had definite disadvantages, particularly with respect to noise. In fact it was recognized that the low fuel consumption was obtained at the expense of smooth and quiet running.

Extensive investigations showed that it was advisable to retain the spherical combustion chamber to give good fuel consumption and cold starting properties, but the disposition of the combustion chamber in the piston crown had to be changed. For good operating characteristics and long life for the piston, it is essential to avoid hot spots and unsymmetrical distribution of the material. Consequently, it was decided to place the combustion chamber symmetrically about the vertical axis of the piston. In addition, the top opening of the combustion chamber has been enlarged so that the diameter of the opening is now nearly equal to the diameter of the chamber, which is therefore almost hemispherical in shape. This arrangement has another advantage over previous designs in that there is no longer an exposed edge which in the orthodox eccentrically arranged combustion chamber hitherto employed was liable to cracking under loads.



M type M.A.N. Diesel

Important modifications also had to be made to the injector to obviate any danger that the nozzle stem would seize in the injector body. For this reason, the injector is so designed that the stem guide is away from the combustion chamber and in a relatively cool zone. This design also allowed the nozzle end of the injector to be made smaller to reduce the surface exposed to the hot gases in the combustion chamber. In addition, a conical collar is fitted at the nozzle end to transmit the heat absorbed by the nozzle direct to the water-cooled walls.

This design ensures that the injector is well cooled right down to the nozzle end with practically complete elimination of deposits in the two nozzle orifices, and on the nozzle and the nozzle seat. To obviate heat stresses that might eventually cause the needle to jam, the conventional yoke fitted on the upper end has been replaced by a spring that rests directly on the nozzle nut. The spring is held down by a collar nut, which also can be used to adjust the spring tension. This arrangement ensures that the injector is held securely in position without being affected by heat stresses or vibrations.

Experience has shown that this engine is remarkably quiet under all conditions from idling to full load and there is no diesel knock even when the engine is started from cold. In comparison with the design which it replaces, it gives smoother and more flexible acceleration. In fact, the fully-loaded vehicle can be accelerated in top gear from walking pace to maximum speed. These improvements in performance have been obtained without any loss of efficiency so far as fuel consumption is concerned, in fact there has also been improvement in this respect. Tests on a level road showed that at 30 m.p.h., which is two-thirds the maximum speed, the fuel consumption was in the order of 23 miles per gallon.

HEADLIGHT SETTING

Part I. An Investigation of Commercial Testers

By V. J. Jehu, M.Sc., A.Inst.P.*

THE aim and performance of headlights impose a limit on the speed at which vehicles can be driven in safety at night. In America, apparatus designed to aim vehicle headlights, and to measure the maximum light intensity emitted by the lamps, has been in use for a number of years. Recently headlight testing equipment has become available in this country and in France, and this article describes tests on British, French and American equipment to determine its accuracy and convenience in handling. The examination was made with a view to recommending standard test apparatus.

It is possible to aim quite accurately the driving beams of the headlights of a vehicle without the aid of specially designed equipment. The important requirements are a floor which is level or which slopes steadily up to or away from a wall of a fairly light and uniform colour, at which the headlight beams can be aimed from a distance of about 25 ft. Two points are then marked on the wall by means of which the beams are aimed parallel to the forward direction of the vehicle and with the correct vertical aim. The aiming points must be spaced equidistantly on either side of the projected centre of the vehicle so that the distance between them is equal to the distance between the centres of the headlamps, and they must be arranged at the appropriate height above ground. The determination of the correct aiming points is a somewhat tedious procedure which can be made easier or eliminated by the use of well-designed testing equipment.

*Road Research Laboratory.

Fig. 2. The Lucas beam setter, showing aligning tube and sighting screen

Beam testing equipment

The five testers examined were the Newnham and the Lucas (British), the Cibié Regloscope (French), and the Weaver and Kent-Moore (American). A description of each type is given below.

The Newnham (Fig. 1). This equipment is designed to simplify and increase the accuracy of the method of aiming headlights by observing their beam patterns on a wall. Feeler arms which pivot about horizontal sighting tubes are placed against the rear wheels of the vehicle which is positioned with its headlights at a distance of either 12½ ft or 25 ft from the wall or from a special screen supplied by the manufacturers. Two sighting rods suspended from a horizontal member attached to the wall or screen are moved across the screen until each bisects the field of view of the appropriate sighting tube. The mid-point between the sighting rods, which is therefore on the axis of the vehicle defined by the rear wheels, is quickly determined by means of a centre zero scale and a marker that can be clamped to the horizontal member. The sighting rods are then re-arranged on either side of the centre point and equidistant from it such that the distance between the rods is equal to the distance between the centres of the headlamps; small markers on the sighting rods are set at the correct height and act as aiming points.

The driving beams of the headlights are then adjusted until the two markers are judged to be at the centres of the beam patterns. No measurement of beam intensity can be made with the equipment. It is understood that a pocket light meter can now be supplied which enables the higher beam intensities to be measured.

Fig. 1. Newnham beam setting equipment

The Lucas (Figs. 2 and 3). The Lucas beam setter consists of an optical system mounted on a carrier which can be wheeled into position in front of the vehicle under test, and auxiliary equipment for lining up the optical system with the axis of the vehicle. The carrier consists of two pairs of tubular guides, one pair being arranged in a vertical plane and the other pair in a horizontal plane. The optical system can be raised or lowered on the vertical guides, which in turn are arranged to traverse the horizontal guides.

The optical system, which is housed in a tube 32 in long and 10 in in diameter, consists of a large condenser lens which projects on to a screen a pattern of the beam equivalent to that which would be obtained at a large distance from the lamp. A small horizontal opening at the centre of the screen allows light to fall on a photoelectric cell mounted behind the screen. The output of the photocell is read on a meter calibrated directly in terms of beam intensity, and mounted immediately above an aperture through which the screen can be viewed. The tube housing is pivoted about a horizontal axis, the movement being controlled by two knobs calibrated in ¼ deg divisions.

The optical system is positioned with respect to the longitudinal axis of the vehicle by means of an aligning tube and an auxiliary screen shown in Fig. 2. The tube contains a lamp and lens system which projects a sharply defined beam of light in the form of a cross

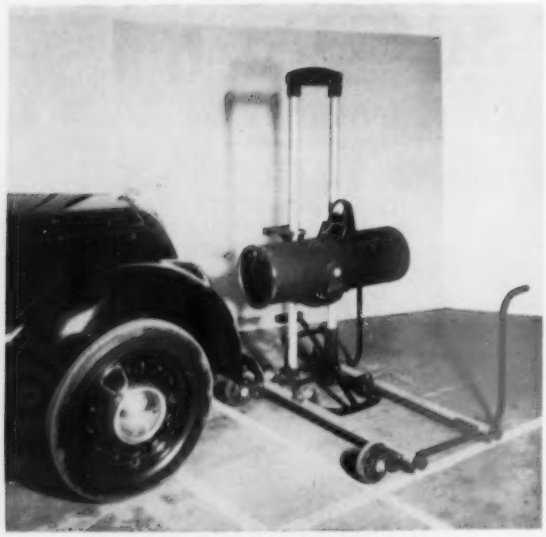


Fig. 3 The Lucas beam setter

along the axis of the tube. The tube is set parallel to the axis of the vehicle by means of feeler arms which are pressed against the rim of one of the rear wheels. It is then set parallel to the floor with the help of the auxiliary screen which is placed alongside the front wheel and which is marked with a cross whose centre is at the same distance from the ground as the axis of the aligning tube. When the aligning tube is thus correctly set, the optical system is brought in front of it and adjusted until its axis coincides with that of the tube, i.e. until the beam of light falls centrally on the screen of the optical system. If it is required that the beams should be set with a small angle of dip, the optical system can be adjusted accordingly. The optical system is then moved horizontally and vertically on the guides until it is in front of the headlamp, which is then adjusted to give a maximum reading of beam intensity on the meter. The procedure must be repeated at the other side of the vehicle since the horizontal traverse of the guides does not allow both headlamps to be aimed from the one setting of the carrier.

The Cibié (Fig. 4). The Cibié Regloscope, like the Lucas beam setter, uses a large condenser lens to project the beam pattern from a headlamp on to a screen. The screen, however, is graduated to suit European meeting beams which are set by a visual assessment of the aim. A more elaborate model incorporating a photocell for checking the intensities is also available. The optical system is mounted on a rigid tubular framework within which it can be raised or lowered. No adjustments of the optical system are necessary apart from movement of the framework as a whole; control of the vertical aim is obtained by designing the apparatus so that the axis of the optical system is parallel to the floor. The optical axis is made parallel to the axis of the vehicle by means of a feeler tube which is pressed against the front tyres of the vehicle. This feeler tube is carried in front of the tester, on two arms of adjustable length. The feeler tube is perpendicular to the axis of the optical system. The tester is placed in front of the vehicle so that the optical system is located in front of, and close up to, the headlamp under test. The feeler tube is then pushed forward with respect to the framework of the tester until it touches a front tyre of the vehicle. An extension tube sliding within the feeler enables the front wheels of the vehicle to be spanned, the final location of the tester being made by pushing it forward until the feeler and its extension make contact with the front tyres of the vehicle under test.

The Weaver (Fig. 5). The Weaver tester consists essentially of an adjustable screen, a device for orienting it correctly in relation to the vehicle, and a photoelectric cell for measuring the light received at the screen. The screen can be raised or lowered on a vertical column which can be rotated carrying the screen with it, or which can be moved on rails across the front of the vehicle under test. A variant of this dispenses with the rails. A gunsight is mounted at the top of the vertical column. The screen can be traversed horizontally by a device called an optoscope, which in turn can be traversed vertically by the photoelectric cell, the output of which is fed to a calibrated meter mounted at the top of the optoscope. The optoscope houses a simple range finder with the aid of which the vehicle headlights can be adjusted to the correct distance (10 ft) from the instrument. A levelling device is provided so that the tester may be adjusted for the floor on which it is used.

When the vehicle has been positioned correctly with the aid of the range finder, the gunsight is used to line up the tester with the centre of the vehicle body and to set the screen perpendicular to the axis of the vehicle. The optoscope is then moved across the screen until the image of the headlight seen on a ground glass screen in the optoscope is bisected by a vertical cross line. The photocell is then moved up or down the optoscope to the setting appropriate to the correct vertical aim of the beam, and the lamp is adjusted to give a maximum reading on the meter. The optoscope and the photocell are then similarly adjusted for the second headlamp. Although the instrument is used at a distance of 10 ft from the headlamps, the horizontal and vertical scales are calibrated in terms of inches deflection at a distance of 25 ft., which is the distance recommended in America for testing the aim of headlights.

The Kent-Moore (Fig. 6). The Kent-Moore headlight tester is similar to the Lucas and Cibié models in that it makes use of an optical system consisting of a condenser lens and screen and, as in the Lucas tester, a photocell is mounted at the centre of the screen. The headlamp under test is brought up to the optical system, which can be raised or lowered on a pair of tubular guides mounted on a platform that runs on rails across the front of the vehicle.

The optical system can be rotated about both horizontal and vertical axes and is fitted with scales which indicate the angular movements, in terms of inches, at a distance of 25 ft. Rotation of the optical system about a horizontal axis is measured by means of a spirit level, the movement needed to return the level to a horizontal position being a measure of the vertical aim of the system. An adjustment of the spirit level is provided so that an initial calibration of the floor may be made.

The optical system is lined up with respect to the longitudinal axis of the

Fig. 4. The Cibié Regloscope

vehicle by means of a gunsight aimed along the top of the bonnet of the vehicle. The correct vertical aim is then applied and the headlights are adjusted in turn to give a maximum reading of beam intensity on the meter.

Results

The accuracy of the reading of vertical aim obtained with all five beam testers depends on the floor of the test site, which must be level or have a uniform gradient, with no surface irregularities. The testers differ in their requirements as to space. The Newnham tester requires at least 12½ ft and preferably 25 ft in front of the vehicle, the Weaver 10 ft, and the Lucas, Cibié and Kent-Moore testers require only sufficient space to accommodate the testers themselves. The only operation involved in determining the vertical aim of a beam is that of estimating, either visually or with the aid of a photocell and meter, when the aim is correct. The limits of accuracy associated with this operation are considered later.

The number of operations necessary to determine the horizontal aim varies from one tester to another. Horizontal aim also depends on a particular property of the vehicle under test.

The accuracy with which a beam will be set or measured depends on the accuracy of the various individual operations which make up the process of aiming or measuring. It is assumed in the discussion which follows that the variances (square of standard deviation) attaching to each operation or vehicle condition can be added together to obtain the variance for the complete process applied to the population of vehicles on the road. The individual variances of the different operations are discussed first and are later combined for the complete process.

Relation between mean wheel axis and the longitudinal vehicle axis used for alignment

The horizontal aim of the headlights of a vehicle should be parallel to the direction of travel determined by its rear wheels when on a flat surface. It is assumed that this direction, which is called the mean wheel axis, is halfway between the separate directions which would be taken up by the undistorted rims of the rear wheels.

The beam testers examined are located with respect to the vehicle in different ways, so that setting and measurement of horizontal aim is likely to vary from one tester to another. None of the testers relate the horizontal aim to that of the mean wheel axis and thus errors in horizontal aim are introduced by the various testers. These errors have been determined.

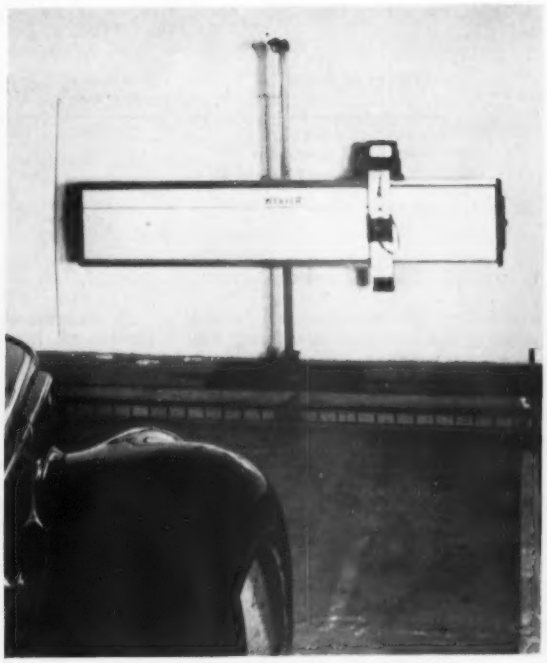


Fig. 5. Weaver headlight tester

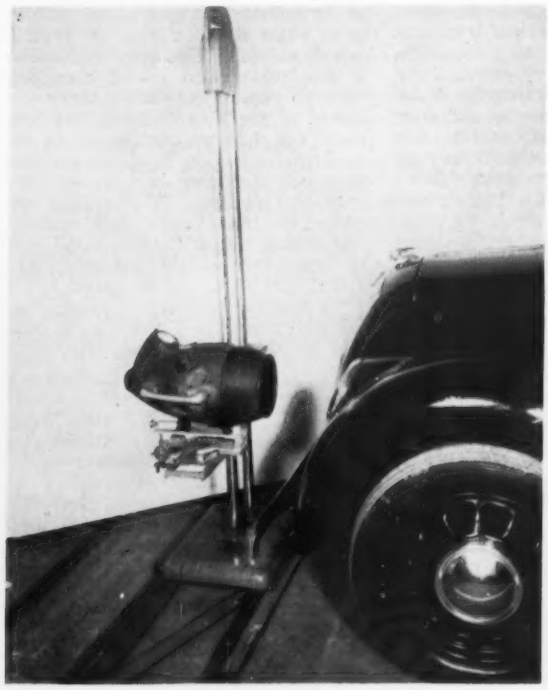


Fig. 6. Kent-Moore headlight tester

The directions assumed by the rims of the rear wheels of eighteen vehicles were measured by means of the Lucas aligning tube and the Lucas beam setter, on the viewing screen of which was marked a scale, in degrees. The beam setter was positioned with respect to the vehicle by means of a jig made up of lengths of aluminium bar assembled in the form of a parallelogram, which was laid on the floor such that opposite sides were in contact with the front tyres of the vehicle and the wheels of the beam setter. The axle of the vehicle was lifted so that the rear wheels were free to rotate, the aligning tube set against one rim, and the reading of the vertical arm of the light cross projected by the aligning tube was noted on the calibrated screen of the beam setter. The rear wheel was then rotated through a half revolution and a second reading was obtained, the mean of the two readings determining the direction which would be assumed by an undistorted rim. The procedure was repeated for the other rear wheel. In this way the relationship between the directions of the rear wheels or the mean wheel axis, and the axis perpendicular to the direction of a line joining corresponding points on the tyres of the front wheels was determined.

The relation between a direction approximating to the mean wheel axis and the body axes was determined with the layout shown in Fig. 7. The body axes of the cars were determined by means of sights pasted on the centres of the windscreen and the rear window; in the case of the vans, the mid-point of the rear door opening was found by wedging across the opening a flexible steel strip, whose centre was marked.

The directions of the rear wheel rims were determined by two sets of Newnham sighting rods, one pair AB (Fig. 7), normally used for beam setting, being mounted about 28 ft. in front of the vehicle headlamps, and the other pair DE, normally used to test the chassis alignment, being mounted close to the vehicle. The Lucas aligning tube was placed against the nearside rear wheel and the two sighting rods A and D were set in line with the vertical arm of the image of the cross of light projected by the tube. The procedure was repeated for the offside

TABLE I. RELATION BETWEEN MEAN WHEEL AXIS AND THE LONGITUDINAL AXES OF THE TESTERS

Source of Error	Variance* (degrees)²	Standard* Deviation	Tester
Wheels from mean wheel axis	0·1218	0·35°	Lucas
Wheel axis from mean wheel axis	0·0156	0·13°	Newnham
Axis determined by front tyres and mean wheel axis	0·1271	0·36°	Cibié
Body axis and mean wheel axis	0·0711	0·27°	Weaver and Kent-Moore

*$\sqrt{\text{Variance}}$ = Standard deviation, σ.

wheel, and the mid-points C and F between the two sets of sighting rods were found; these points determine the direction of the wheel axis. The corresponding points X and Y defining the direction of the body axis were found respectively with the central marker of the Newnham equipment and with a plumb line. Each vehicle was then moved back until the wheels were turned through a quarter of a revolution and the procedure was repeated, so that the direction of the body axis was found in relation to a direction which approximated to that of the mean wheel axis.

The Lucas beam setter relates the aim of the headlamps individually to the direction taken up by the appropriate rear wheels. The Newnham equipment relates the headlamp aim to a direction found for the wheel axis which is halfway between the individual directions obtained for the rear wheels. The Cibié tester relates headlamp aim to a direction perpendicular to that of a line joining corresponding points on the tyres of the front wheels of the vehicle, whilst the Weaver and Kent-Moore testers relate the direction of the headlamps to that of the axis of the body of the vehicle.

The relationships between the longitudinal axes used by the various testers and the mean wheel axis obtained from the measurements made on eighteen vehicles are given in Table I. The divergence between the longitudinal axes and the mean wheel axis is comparable for all the testers except the Newnham equipment, whose longitudinal axis is most nearly related to the mean wheel axis.

In a large number of tests,

99·8 per cent of the results would be approximately within $\pm 3\sigma$ of the mean value.

95 per cent of the results would be approximately within $\pm 2\sigma$ of the mean value.

90 per cent of the results would be approximately within $\pm 1{\cdot}65\sigma$ of the mean value.

75 per cent of the results would be approximately within $\pm 1{\cdot}15\sigma$ of the mean value.

50 per cent of the results would be approximately within $\pm 0{\cdot}67\sigma$ of the mean value.

Instrumental errors in the measurement of horizontal aim

In addition to the errors due to the differences in direction between the mean wheel axis and the longitudinal axes appropriate to the various testers, the errors introduced into the measurement of horizontal aim by the process of positioning the testers with respect to the vehicle must be considered.

The Lucas. The aligning tube of this instrument takes up a position which is independent of the irregularities of the floor, so, provided that the tubular guide rails are not distorted, no error in horizontal aim is introduced by the instrument.

The Newnham. Each of the feeler arms used in this equipment is in contact with the floor at two places. An irregular floor can thus misalign the sighting tube about which the feeler arms pivot. An estimate of the error introduced from this source was obtained by taking measurements with both the Lucas and Newnham sighting tubes on a smooth floor and on a somewhat rougher patch of floor, the variation in the results obtained being attributed to the errors introduced by the Newnham sighting tube.

The Cibié. The positioning of the Cibié tester requires the setting of the front wheels to the straight ahead direction of the vehicle, and depends on the operator's judgment of the position of the front wheels.

The variation of direction likely to be introduced by this cause was determined by mounting a lamp with a very sharp vertical cut-off on a car which was driven forward to the test site. The floor jig in the shape of an accurately assembled parallelogram was used to position the Lucas beam setter with respect to the car. The setting of the vertical cut-off of the beam was noted on the calibrated screen and the procedure repeated to obtain ten readings of the total variation in direction introduced by an operator's judgment of the setting of the front wheels and by the alignment procedure, the latter being found separately from tests with a stationary vehicle.

An additional error in the positioning of the Cibié tester is introduced by the instrument itself. The front tyres of the vehicle are spanned by an arrangement of two tubes, see Fig. 4, one of which slides loosely within the other; the outer tube rests against one tyre, and the protruding end of the inner tube against the other. When the tester is pushed up to the vehicle, the play between the two tubes allows the tester to take up a position whereby its longitudinal axis is at a slight angle with that of the vehicle. This angle is usually greater the more the inner tube has to be pulled out to span the front wheels. As a consequence, the offside lamp of the vehicle is aimed slightly towards the nearside, and the nearside lamp is aimed slightly towards the offside.

The errors in setting introduced in this way on a modern car were found by using a lamp with a very sharp vertically cut-off beam, mounted first on the nearside and then on the offside, at an equal distance from the central axis of the car. The lamp was aimed so that the vertical cut-off coincided with the vertical line marked down the centre of the Cibié screen, and the tester was then removed to obtain the horizontal aim of the cut-off on a screen calibrated in degrees at a known distance from the lamp. The procedure was carried out ten times for both nearside and offside lamps. It was found that the angle between the two beams was 1 deg, both lamps being turned about ½ deg towards the centre of the vehicle. On wide commercial vehicles, the misaim would be greater than this.

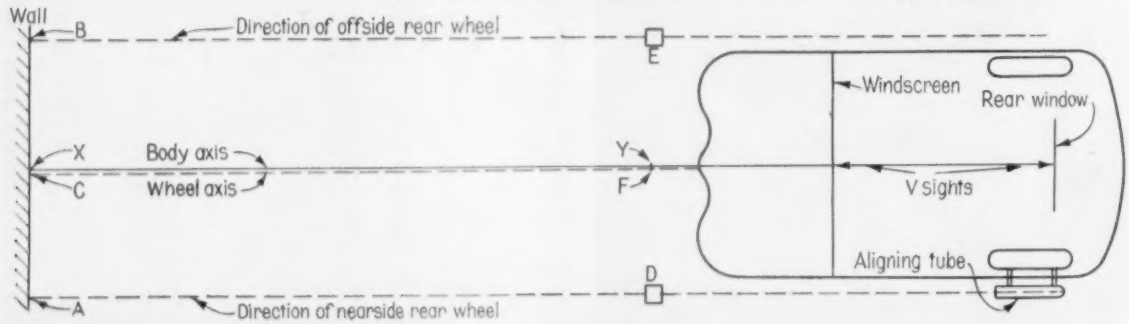


Fig. 7. Method of determining relation between mean wheel axis and body axes

The Weaver and Kent-Moore. The accuracy with which the Weaver and Kent-Moore instruments can be aligned with respect to the vehicle under test depends on the operator's assessment of the coincidence of the vehicle's bonnet ridge with the respective gunsights attached to the testers. In both cases, the sighting operation involves two adjustments, one a movement of the tester transversely to the vehicle, and the other a rotation of the tester about a vertical axis. The setting of the tester is liable to error because it is difficult for the eye to focus a near object and a more distant one at the same time. To determine the error involved, five observers aimed the testers ten times each at a vehicle with a ridged bonnet. The variation both in the transverse movement and the rotation of the testers was measured, the former by reference to a datum on the rails on which the testers moved, and the latter by means of a small piece of mirror attached to the tester. The mirror reflected light back to a graduated screen from a torch mounted at its centre, so that movements of the spot of light seen on the screen were proportional to the rotation of the tester.

The results of the tests described above are given in Table 2.

TABLE 2. ERRORS OF HORIZONTAL AIM INTRODUCED IN POSITIONING THE TESTERS

Source of Error		Variance	Tester
Irregularity of floor surface	(smooth floor)	0·0048	Newnham
	(rough floor)	0·0290	
Operator's judgment of setting of front wheels		0·0200	Cibié
Play in tubes spanning front tyres		0·0059*	
Setting of gunsight	(ridged bonnet)	0·0176	Weaver
	(no ridge)	0·1876	
Setting of gunsight	(ridged bonnet)	0·0268	Kent-Moore
	(no ridge)	0·1250	

*Nearside lamp aimed ½° to offside.
Offside lamp aimed ½° to nearside.

Variability of repeat readings of vertical and horizontal aim

Having examined the errors involved in positioning the beam testers with respect to the vehicle, the limits of accuracy of repeat readings of horizontal and vertical aim were determined for the various testers. This was done for the Weaver and Kent-Moore testers by repeatedly operating the instrument controls to find the direction of the maximum intensity for a fixed headlight beam. In the case of the Lucas tester, only the vertical aim could be examined in this way since no adjustment of horizontal aim is provided; horizontal aim was examined by repeatedly setting the headlight beam until the beam intensity indicated by the meter was a maximum. With the Newnham tester also, the headlight beam was repeatedly aimed at a fixed marker to determine the repeat accuracy of both vertical and horizontal aim. Five observers each took ten readings on each beam tester, a block lens F700 Lucas lamp being used to supply the beam pattern. No measurements could be made with the Cibié tester because the calibration of its screen was suited only to European headlight beams.

The Newnham. The lamp was mounted at a distance of 28 ft 8 in from a screen marked with a 6 in grid, each 6 in step corresponding at that distance to a movement of the lamp of 1 deg. Another graduated screen was mounted to the side of the headlight beam at a distance of 14 ft 4 in from the headlamp. A small piece of mirror attached to the front of the headlamp lens reflected a spot of light back to the screen from a torch mounted at its centre. With the torch off, the observer directed the headlight beam at the marker; the torch was then switched on, the position of the light spot on the second screen noted and the procedure repeated.

The Lucas. The carrier was positioned in front of the headlamp and readings were taken of the vertical aim of the optical system corresponding to maximum readings of beam intensity on the meter. It was found that the mechanism controlling the vertical aim given to the optical system had an appreciable amount of backlash. In order to measure the backlash, each observer took ten readings in which this backlash was included in the movement of the adjustment, and ten readings in which it was not included. Horizontal aim was investigated by repeatedly setting the headlight beam until a maximum reading of beam intensity was shown on the meter of the tester, the scatter of the settings being measured by the deflection of a beam of light reflected from a piece of mirror attached to the headlamp lens.

The Weaver and Kent-Moore. The operator repeatedly adjusted the controls of vertical and horizontal aim until a maximum reading of the meter was obtained from a fixed headlight beam. The results obtained for repeat settings of the testers are given in Table 3 in which the variances are the mean values for five observers.

TABLE 3. THE ACCURACY OF REPEAT READINGS OF VERTICAL AND HORIZONTAL AIM

Variance of Aim of Beam		Tester
Vertical Aim	Horizontal Aim	
0·0090	0·0324	Newnham
0·0038	0·1366	Lucas
(difference of mean values with and without backlash 0·63°)		
0·0025	0·0520	Weaver
0·0070	0·0189	Kent-Moore

Total variation in measurement of vertical and horizontal aim

The sum of the separate variances in the setting of the horizontal aim of a headlight beam may now be found for the testers examined; vertical aim involves only the accuracy of repeat readings. The standard deviations obtained for the complete process of setting the headlight beam both vertically and horizontally are given in Tables 4 and 5.

It appears that with all the testers, vertical aim can be set more accurately than horizontal aim. It also appears that the Newnham equipment, which relies on a visual estimate of aim, is capable of an accuracy of setting which, for vertical aim, is almost as good as that of the testers which use the maximum reading of a meter to indicate correct aim. The accuracy of setting of horizontal aim is better with the Newnham equipment than with the other testers.

TABLE 4. THE OVERALL ACCURACY OF THE SETTING OF VERTICAL AIM

Tester	Source of Variance	Variance	Standard Deviation
Newnham	Variance of repeat settings	0·0090	0·09°
Lucas	Variance of repeat readings	0·0038	0·06°
	Difference of mean values with and without backlash		0·63°
Cibié	No measurements made		
Weaver	Variance of repeat readings	0·0025	0·05°
Kent-Moore	Variance of repeat readings	0·0070	0·08°

TABLE 5. THE OVERALL ACCURACY OF THE SETTING OF HORIZONTAL AIM

Tester	Source of Variance		Variance	Standard Deviation
Newnham	Variance between wheel axis and mean wheel axis		0·0156	
	Variance due to floor	(smooth floor)	0·0048	
		(rough floor)	0·0290	
	Variance of repeat settings		0·0324	
		(smooth floor)	0·0528	0·23°
	Total	(rough floor)	0·0770	0·28°
Lucas	Variance between wheels and mean wheel axis		0·1218	
	Variance of repeat settings		0·1366	
		Total	0·2584	0·51°
Cibié	Variance between axis determined by front tyres and mean wheel axis		0·1271	
	Variance of front wheel setting		0·0200	
	Variance in positioning tester		0·0059	
	Variance of repeat settings		no measurements made	
		Total	0·1530	0·39°
	(Variance and standard deviation apply only to alignment of tester)			
Weaver	Variance between body axis and mean wheel axis		0·0711	
	Variance of gunsight setting	(ridge)	0·0176	
		(no ridge)	0·1876	
	Variance of repeat readings		0·0520	
		(ridge)	0·1407	0·37°
	Total	(no ridge)	0·3107	0·56°
Kent-Moore	Variance between body axis and mean wheel axis		0·0711	
	Variance of gunsight setting	(ridge)	0·0268	
		(no ridge)	0·1250	
	Variance of repeat readings		0·0189	
		(ridge)	0·1168	0·34°
	Total	(no ridge)	0·2150	0·46°

Limitations of the beam testers

The most essential requirement of a beam tester is that the accuracy with which the headlights of a vehicle can be set with the tester should be independent of the design of the vehicle. Two of the testers examined, the Weaver and the Kent-Moore, do not meet this requirement because they rely for the accuracy of the setting of horizontal aim on the view along the bonnet of the vehicle. The flat-fronted design of most modern commercial and public service vehicles, however, makes it quite impossible to set the horizontal aim of such vehicles by means of a gunsight.

The Newnham and Lucas testers, which base their settings of the horizontal aim of headlight beams on the directions taken up by the rims of the rear wheels, are not so restricted in their use. In fact, the accuracy of the horizontal aim obtained with the Newnham tester is independent of the design of the vehicle with the possible exception of three-wheeled vehicles with one rear wheel. A disadvantage of the Newnham tester, however, is that it requires a large area of level floor space at a site which for preference should be partially darkened; other drawbacks are that the procedure is somewhat tedious, two operators are required for part of the time and, except when a pocket meter is supplied, no indication of beam intensity is provided.

The Lucas tester aims each headlight beam with respect to the appropriate rear wheel rim, and can deal with the same vehicle types as the Newnham tester. With the Lucas tester, however, provision must be made for vehicles designed with toe in or toe out of the rear wheels, by the addition of caps to the feeler arms of the alignment tube. Although only one operator is needed to adjust the headlights of a vehicle with the Lucas tester, the procedure is tedious since the alignment tube and the carrier of the tester must be set up for each headlight. Another disadvantage is the method used to adjust the vertical aim of the optical system and the calibration of the adjustment. Apart from the considerable backlash in the adjustment, the lack of any indication of the whole number of degrees given to the vertical aim of the optical system is confusing in that a dip of 1½ deg can easily be mistaken for a dip of ½ deg or 2½ deg.

The method used by the Cibié tester, of locating the instrument by means of the front tyres of the vehicle, is easily carried out; it has been shown that the accuracy of positioning the apparatus obtained by this method is comparable with that obtained using the more tedious method employed by the Lucas tester. The instrument itself, however, introduces an error in the setting of the horizontal aim of headlight beams which amounts to an angle of 1 deg between the beams for private cars, and which increases as the track of the vehicle under test increases. Subject to this limitation, the Cibié tester can be used to set the headlights of most vehicles. It cannot, however, deal with the type of modern coach which possesses a large forward overhang, the feeler tube being unable in this case to reach the front tyres. A less common class of vehicle whose headlights cannot be aimed horizontally by means of the Cibié tester, is the three-wheeled vehicle with one front wheel. It was not possible to measure beam intensities with the model examined, but on some models of the tester a small light meter can be mounted at the viewing screen. The Cibié is the only one of the five beam testers examined in which the alignment procedure is simple enough for it to be used on other than suitably prepared sites, although its use in the open in daylight would be somewhat limited because the viewing screen is not shielded against light from the sky.

Conclusion

None of the headlight testers examined is entirely satisfactory in its present form as a standard piece of equipment for use in garages and for checks at the roadside. All the testers are capable of setting the vertical aim of the headlights of all vehicles to a fair degree of accuracy, but only one of them, the Cibié, is, in principle, capable of setting the horizontal aim of the beams both accurately and conveniently. Even in the Cibié tester, full advantage has not been taken of the method of setting the horizontal aim.

TIPPERS

AN unusual refuse collection body patented by M. R. Favrat was exhibited at Geneva. It employs forward tipping to compress the load, and is unloaded by the usual rearward tipping method. On a 12-cubic yard body, it is claimed that compression of up to 50 per cent is obtained as a result of tipping the body forward to a maximum tip of 82 deg. Loading is through a 2-cubic yard dropped extension at the rear of the main container. Two small hydraulic rams lift this extension up until its contents are discharged through hatches in the roof of the main container, which can be tipped forward with the loading extension either in the raised or lowered position.

Another ingenious hydraulic tipping gear is the Wirz. This design utilizes two jacks which cause a gantry at the rear of the frame to rotate, either to tip a container, or to slide the container along guides in the sub-frame of the body until the container is suspended horizontally above the ground. Further movement of the gantry lowers the container on to the ground, where it may be detached for loading by hand, on the ground, while the vehicle hoists a loaded container, and returns to service.

AMERICAN BODYWORK

Features of Some of the 1954 Models

So far as styling is concerned, there have been few changes in American conceptions during the past twelve months. Some innovations have been introduced but most are in the nature of stunt features rather than generally accepted trends. For example, some inconsistencies were apparent at the recent Geneva Show, where imitation wire spokes on disc type wheels were to be seen on one model, and imitation discs on wire spoked wheels on another.

Among the more permanent changes that have been made is the abandonment of the binnacle type instrument assembly mounted on the steering column. In some cases, but not all, this has been replaced by a similar instrument housing on the dash facia immediately above the steering column. The new arrangement seems to be more practicable because, when the instruments are in the more remote position, on the facia, less effort is required of the driver to re-focus his eyes when glancing down at them. Moreover, assembly and material costs are undoubtedly slightly less with the latest arrangement.

The widespread adoption of exterior mounted spare wheels by American manufacturers seems to be a retrograde step. Admittedly this leaves the boot completely clear for the accommodation of luggage, but there is no entirely suitable place on the exterior of a modern vehicle for stowing the wheel. If it is carried on the boot lid, the extra weight that it adds to this component introduces hinging problems. On the other hand, if it is placed vertically behind the boot it tends to be in the way when heavy cases have to be stowed. Moreover, it would appear to be difficult for the person loading or unloading the boot to avoid brushing his clothes against the spare wheel, and however well this component is encased, it is unlikely that it can always be kept in a spotlessly clean condition. It is improbable that this feature will remain popular for long.

The hard-top form of canopy is much in demand. In future, more attention will probably be concentrated on providing better all-round visibility. This will involve appreciably reducing the cross sectional dimensions of all the pillars above the waist. To do this, it will be necessary to concentrate the main structure of the vehicle in the base instead of making use of the pillars and roof panels. This will simplify the design of an alternative drop-head version of a saloon type body. The problem of providing sufficient strength to protect the occupants in the event of the vehicle turning over may also have to be studied.

Nash Rambler Sedan

The latest addition to the Nash range of models is the Rambler four-door sedan. This vehicle is designed to seat five or six people and is powered by the 90 b.h.p. Super Flying Scot engine. According to the brochure issued by the Nash-Kelvinator Corporation, the car "is available with optional Airliner Reclining Seats, twin beds and a choice of three transmissions." The squabs of these reclining seats are adjustable and can be set in any position from the horizontal to the vertical.

An outstanding feature of the Nash bodies is the way in which they are designed for ease of production. From the illustrations, it can be seen that there are no soldered joints nor are there any deep draws in the body panels. At the rear, there is a vertical joint underneath each rear lamp and a horizontal one extending to the lower edge of the boot opening. On each side of the boot there is a longitudinal joint between the rear quarters and the centre decking panel, which is a separate component. The rear skirt and apron panels are also separate. A number of longitudinal swages, or flutes, are pressed in the rear apron to give it rigidity and to prevent drumming. At the front of the vehicle, there is a vertical joint line beneath each head lamp and a horizontal one on each side, extending to the front of the bonnet opening. The panel on which the grille is mounted is a separate component and is turned forward into the bumper section so that a front apron is not necessary.

There are no deep draws in the panel pressings of the Nash Rambler four-door Sedan styled by Pinin Farina

Glass fibre mat, $\frac{1}{4}$ in thick, is secured to the under-surface of the bonnet lid. It is stuck on and retained by two very heavy gauge cross wires. The ends of these wires are attached to the longitudinal stiffening members at the sides of the bonnet lid, and at their centres, they are secured to brackets on two cross members, one at the front and another at the rear. The longitudinal stiffening members are of 16 S.W.G. channel section and are spot welded to the sides of the lid. Between the hinges at the rear is a top hat section boxed in by a closing plate. The two components of this section appear to be of about 20 S.W.G. and its ends are welded to two 16 S.W.G. pressings attached to the longitudinal members. These pressings carry the hinge links.

A forward-facing air-intake scoop is fitted at the front of the bonnet lid. It is a steel pressing, with its rear edge turned through 180 deg and then flanged downwards and spot welded to an inwardly turned flange at the rear edge of the hole in the bonnet, over which it is fitted. The front edge of the pressing has a number of tongued extensions; it is turned downwards and to the rear, and the tongues are turned downwards again. The end of each tongue is spot welded to the inwardly turned flange at the front edge of the hole in the lid. Also spot welded to this edge, but carried under the lid, is a pressing that stiffens the front end of the bonnet lid and carries the catch. This catch is released from inside the radiator grille. The front edge of this stiffener is spot welded to the turned-in leading edge of the lid. Along each side, the wing panel is bolted to a longitudinal member, of box section, extending along the top of the wheel arch. The lower wall of this box section is formed by the wheel arch panel which, like many other panels in this vehicle, is well swaged to prevent drumming.

Baffle plates are fitted on each side of the radiator, for which they form the only support. A closing plate is welded between the top edge of these baffles and the front skirt panel. The battery is carried in an extremely accessible position immediately behind one of these radiator baffles. It is mounted on a tray, the rear edge of which is carried on a simple bracket, of strip steel, spot welded to the wheel arch. The front edge is supported on a channel section cross member, which, at its ends, is welded to the tops of the

wheel arches. At the centre, this cross member is supported by gusset struts, which have their lower ends welded to the side members of the frame. Undoubtedly these struts are necessary to prevent resonance of the horizontal channel section at certain engine speeds.

A gauze-covered air intake extends the full width of the scuttle top. It serves the heater and fresh air system. For two reasons, many manufacturers favour this position for the air intake, in preference to positioning it in the radiator grille. One is that this arrangement obviates the need for long ducts; these take up an appreciable amount of space under the bonnet and are expensive. The second reason, which is the one that receives more publicity, is that in traffic jams, exhaust fumes will not be drawn into the system directly from the exhaust pipe of the car in front. In the Nash Rambler the heater is installed on the centre of the dash, immediately below the scuttle air intake.

Door handles of unusual design have been adopted. They are streamlined in shape and incorporate centre sections which are hinged horizontally adjacent to their upper edges, and which are pulled outwards to unlatch the doors. The windows on the doors are surrounded by chromium plated strips, the outer faces of which are grooved ornamentally in a manner commonly seen on picture frames. The 90 deg corners of these strips, adjacent to the top of the centre pillar, are mitred. Glass ventilating panels are fitted on the front and rear doors. That at the front is of conventional triangular shape, but the trailing edge of the rear one is curved to follow the lines of the cant rail and rear pillar. This gives an unusual door opening line at the rear pillar but it gives additional clearance at shoulder level and is a good feature from the point of view of ease of entry to the vehicle.

The doors are hung on simple $\frac{1}{8}$ in thick, pressed steel hinges. Large arm-rests are mounted on the inner panels. Recesses are cut adjacent to the leading edges of these arm-rests so that they may be gripped and used as pull-to handles. There are no pockets on any of the doors, but pull-out type ashtrays are fitted to the rear ones.

The spare wheel on the Nash Rambler hinges backwards when the lever between it and the body panelling is lifted

On the dash, a binnacle type instrument is mounted on the facia immediately above the steering column. Below this instrument is a hole through which the steering column is passed, and the hub of the wheel is so close to the facia that it gives the appearance of being mounted directly on it. In the instrument panel are a speedometer dial, oil pressure and dynamo charge warning lamps, and the water temperature and fuel contents gauge dials. The ignition switch, choke and other control knobs are mounted in a row on a small panel under the facia to the right of the steering column. Above it is the radio and its controls, and further to the right is a clock. An unusual feature of the dash arrangement is an exceptionally deep drawer on the passenger's side. This drawer is carried immediately under the facia, and its base slopes up towards the front to clear the knees of the passenger. It is locked by a simple press button catch.

The front floor is covered with rubber sheeting only. On the toeboard, under-felt is used beneath the rubber covering. Rubber and felt are also fitted over the gearbox panel. Rubber sheeting is employed on the rear floor, but felt is laid in the foot wells.

Buick models

This year, Buick have introduced a four-door sedan and two-door convertible and hard top models. One of the most interesting features common to all these new vehicles is the wrap round windscreen. This new windscreen arrangement does not appear to have been introduced purely on its own merits, but rather because it was the best for the particular vehicle layout adopted.

To obtain a low bonnet line, and therefore good forward visibility, as well as to give good weight distribution, the V8 engine has been installed behind the cross member supporting the front suspension. This has involved positioning the toeboard and consequently the front seats a relatively long way back. To have brought the windscreen back a corresponding distance would have inordinately lengthened the bonnet. On the other hand, a forward positioned screen with conventional side pillars would be impracticable since, if the pillars were so far ahead they would cause considerable obstruction in the forward range of vision.

The solution adopted has been to wrap the ends of the screen round the sides and to put the pillars in approximately the same position relative to the driver as those in vehicles of more conventional layout. In designs of this type it is of prime importance that the curvature of the glass shall be such that there is no distortion over the driver's whole field of vision. Inspection of two models showed that there is no detectable distortion on the Buick vehicles.

From the structural point of view, this wrap-round arrangement introduces a potential weakness, since it places the door and windscreen pillars out of alignment. However, from this it should not be inferred that the Buick

In the Nash Rambler, the heater is mounted on the centre of the dash, and the battery is in an accessible position immediately behind the radiator, where it is carried on a tray supported by a light cross member and a bracket on the wheel arch

Because the engine is positioned well back in the Buick Super, the space between the dash and the facia is restricted. Therefore, to accommodate the instruments and controls, holes are cut in the dash and dished pressings are bolted over them

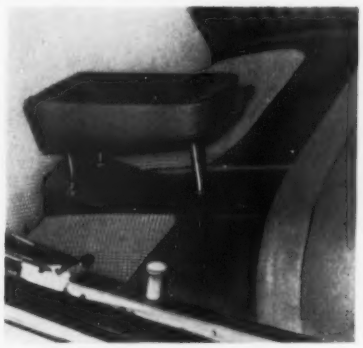
models are structurally unsound. Undoubtedly the strength of the vehicle is built into the structure below the waist line. This has the advantage that there need be no major structural differences between the saloon and convertible models.

Because the engine is positioned so far back, a special dash facia arrangement has also been necessary to provide room for the wiring and controls between it and the dash. The lower half of the facia is of semi-cylindrical form with its axis horizontal and its convex face towards the interior of the vehicle. With this arrangement it has been possible to dispense with a separate quadrant for the three heater-control levers. Instead, slots are cut vertically in the semi-cylindrical portion of the facia. These slots are reinforced with quadrant plates, and the levers project through them. As can be seen from the accompanying illustration, the whole assembly is immediately to the right of the steering column. The centre lever controls the demisters, the left-hand one is for the main heater unit mounted under the driver's seat, and the right-hand control is for an auxiliary heater mounted on the dash on the passenger's side of the vehicle. Tumbler switches serving the electric fans are fitted at the top ends of the quadrant plates of the levers on each side.

When the left-hand lever is in the "up" position, the air temperature in the car is thermostatically controlled and warm air is supplied from the main heater under the seat. In the "down" position, fresh air only is fed into the car, and when in the centre the lever is in the "off" position. The switch above this lever controls the two-speed fan of the main system. When the centre lever is in the "up" position, the demister ducts, which are supplied with warm air from the auxiliary heater, are open; they are closed when it is moved down. The right-hand lever is pulled up to direct warm air from the auxiliary heater into the car. In the "down" position, only unheated air is supplied. To obtain the maximum output from the demister system, the right-hand lever must be in the "off" position, which is in the centre of the quadrant. However, under normal conditions, both the demister and heater services are more than adequate. The switch above the right-hand lever controls the single-speed blower that serves the auxiliary heater. This blower is mounted on the dash under the bonnet.

A wrap round windscreen is employed on the Buick Super

Above the semi-cylindrical portion of the facia is a chromium plated horizontal panel, on which are mounted the radio and all the instruments except the speedometer. On the facia immediately below the horizontal-reading speedometer, and symmetrically disposed about the axis of the steering column, are four large diameter instrument dials mounted on the horizontal chromium plated panel. One indicates the radiator temperature and the others are the oil pressure and petrol contents gauges, and ammeter. The radio and its controls are in the centre of this panel and on each side of it are pull-out ashtrays. Immediately to the right is a clock, and a glove box is provided on the extreme right-hand side.



The arm-rest on the back seat of the Studebaker Starliner is removable

An unusual feature of the controls is that the parking brake is pedal operated, and the ratchet is released by a control knob under the facia. A red lamp wired through the ignition switch is on the extreme left of the facia and gives warning when the parking brake is on. Foot operation of the parking brake is easier than hand actuation and is a good feature, but is only practicable when a two-pedal control system is adopted. The control can be placed in such a position that it does not obstruct the floor space round the front seats.

Electrically operated window lifts are fitted in both doors. That on the passenger's side is controlled by a single switch on the waist rail of the door, while two switches are provided on the driver's side so that he can control both windows. Small rectangular glass panels are pivoted on the windscreen pillars in such a manner that they can be made either to act as deflectors to direct air into the vehicle or as extractors. The hood on the convertible body is actuated by an electro-hydraulic mechanism.

Other models

Among the new models introduced by Studebaker is the Starliner. This is a two-door, hard-top saloon designed

Three controls, one for each of the two heaters and the other for the demister ducts, are mounted on the dash facia to the right of the steering column in the Buick Super

A simple facia layout is employed on the Ford Crestline, and a green glass panel is fitted in the front portion of the speedometer housing

An uncommon type of exterior door handle is employed on the Nash Rambler; the centre portion, which is hinged along its upper edge, is pulled outwards to open the door

On the Studebaker Commander, the methods of joining the chromium plated strips, and the arrangements to provide for their continuity are of interest

to accommodate five people. The new vehicle is based on the same chassis as last year's model but the body incorporates a number of new features. There is no framing round the drop window on the door, and the glass is guided by a vertical channel at its front edge. The rear quarter light pivots down into the panel below it. Thus, visibility on each side is unobstructed over the length between the rear pillar of the hard-top roof panel and the glass ventilating panel on the front of the door.

All the side lights are sealed along their top edges by an inverted channel section mounted under each cant rail. The front arm of that portion of the channel section which is over the door is hinged and spring-loaded so that, as the door is opened, it springs outwards to clear the top edge of the glass. When the door is closed again, the upper end of the vertical frame immediately behind the ventilating panel strikes one arm of a bell-crank lever that returns the channel to the closed position, thus providing an effective seal.

Another unusual feature of this car is the arrangement of the centre armrest on the back seat. This is mounted on three legs made of chromium plated steel tube. The lower ends of the legs register in sockets on the seat pan and the whole unit can be lifted out to provide more room.

On the dash, all the switches except that for the ignition circuit are of the tumbler type, and each has an exceptionally long operating lever so that it can be easily flicked over. To protect the levers from damage, they are housed in deep hemispherical cups countersunk in the horizontal chromium plated strip on the facia. This strip extends the full width of the facia. Below it the instruments are carried immediately above the steering column in a housing on the facia.

The Studebaker Commander, V8 Regal exemplifies the modern American practice of making extensive use of chromium plated strip round the windows and on other parts of the body. The concealment of joints in such strips is a problem that always has to be faced and, as can be seen from the illustration, more than one method is used even on adjacent parts of this car. On each side of the rear light a small capping piece is fitted over the joint. Nearby, on the strip round the window on the rear door, a simple butt joint is used despite the fact that the strip is discontinuous over the centre pillar. Another butt joint is incorporated on the horizontal rubbing strip across the centre of the door. This joint marks a discontinuity in the panel profile.

An unusual instrument has been adopted on the Ford Crestline. The speedometer is behind a semi-circular clear glass on top of the facia above the steering column. The front wall of its casing is of green glass. At night time, when the instrument is illuminated, this glass diffuses a green light behind the scale and needle of the instrument so that it can be read easily. Warning lamps for the oil pressure and dynamo are carried at each end of the horizontal frame at the base of the instrument.

DIESEL EXHAUST VALVE LIFE

AN article entitled "Factors Affecting Diesel Exhaust Valve Life," by J. A. Newton, J. L. Palmer and V. C. Reddy, was published in an *S.A.E. Preprint*, November 3-4, 1953. It is stated that breakage is the outstanding exhaust valve problem in diesel engines, and is usually caused by thermal fatigue, but sometimes from impact fatigue. Therefore, an exhaust valve material should have good resistance to both. Resistance to burning at high temperatures is also necessary. A laboratory test rig, in which the valve is alternately heated by an induction coil and cooled by the use of a water cooled seat, has shown encouraging results in the rapid evaluation of the thermal fatigue properties of various valve materials. Knowledge has been gained of the influence of facing materials on thermal fatigue.

Valve guttering, when not caused by unsatisfactory cooling or inferior valve material, invariably arises from conditions which prevent proper valve seating. These are:—

1. Cracks or flaws in the valve face or seat.
2. Warping or distortion of the valve head, seat and/or cylinder head.
3. Peening or Brinelling of face or seat by metal chips or hard particles of combustion chamber deposit.
4. Insufficient valve lash.
5. Sticking of the valve stem in its guide.
6. Brittle deposit on the face or seat which subsequently chips off, leaving a channel for escape of the hot gases.

The type of guttering most difficult to correct is that arising from cylinder head distortion. To combat deposit formation, a seat angle of 45 deg may be preferable to one of 30 deg. Where face deposits are a serious problem, the incorporation of an interference angle between the face and the seat is good practice but is inadvisable with rotated valves.

Accelerated testing indicated the superiority of 30 deg seats on valves made of faced or unfaced GM N81940 over 45 deg seats on valves of the same material. A jet turbine blade material, N-155, proved to have exceptional resistance to cracking and was adopted for production. Valves of this material operated satisfactorily for over 2,000 hours, compared with 600-800 hours obtained with faced GM N81940 and less than 200 hours for the unfaced alloy. However, it is not possible to prescribe a valve design or material for universal application. For any particular set of operating conditions, optimum design and material may be determined only through experience and testing. *M.I.R.A. Abstract No.* 6589.

NEW PLANT AND TOOLS

Recent Developments in Production Equipment

An addition to the comprehensive range of Edgwick machine tools designed and engineered by the Factored Division of Alfred Herbert Ltd., Coventry, is illustrated in Fig. 1. It is designated the Edgwick Junior threading machine, and is intended for threading small components, pipes up to $\frac{1}{2}$ in diameter and bolts up to $\frac{3}{8}$ in diameter. The maximum length that can be threaded is 3 in. A particular feature of this machine is the lightness of touch required for carriage movement. This is an essential for cutting small-diameter, fine-pitch threads.

The hollow spindle is flanged and is mounted on precision pre-loaded anti-friction bearings that are sealed against the possible entry of coolant and swarf. Suitable adaptors allow any of the following dieheads to be used:—

(a) Coventry $\frac{1}{2}$ in CHS rotary type. Owing to the low cost of the dies this diehead is particularly suitable for small batch work involving a variety of pitches.

(b) Tangar $\frac{3}{8}$ in and Landis/Lanco $\frac{7}{16}$ in rotary type. These are fitted with the tangential-type of chaser and are suitable for large production batches. The design is such as to give immediate support behind the chaser cutting edge, thereby ensuring rigidity and precision.

(c) Landis/Lanco $\frac{3}{8}$ in VV rotary type. This type will give long life and precision on heavy duty work. All the component parts are made from heat-treated alloy steel. Simplicity and quick positive action allows the most exacting production demands to be met.

The adaptors are so arranged that any swarf which passes to the back of the diehead is flushed away to the removable swarf basket located in the sump. As a result the diehead always works under good conditions, and coolant leakage through the spindle is avoided.

Drive to the spindle is by a vee belt from a 4-speed rotor stator unit. The whole of the driving mechanism is fully protected by guards. There are four reversible speeds, 260, 420, 560 and 840 r.p.m. Speed selection is by a star wheel on the front of the machine, and the reverse is obtained by moving a lever behind the speed-selector dial. If necessary, the speed range can be varied by fitting different pulleys.

The carriage is mounted on two ground steel bars. Forward and reverse movements are obtained through a link motion that is controlled by an adjustable hand lever. An adjustable work-stop is provided. A useful feature of the carriage design is that for handling awkward shaped components, the vice can be removed as a unit and special fixtures fitted in its place. Opening and closing of the diehead is controlled by the carriage movement, which actuates the yoke operating mechanism through an adjustable screwed rod.

A fully adjustable vice, similar to the well-known Landis design, is operated by a hand-actuated adjustable lever. If required, a power-operated vice can be fitted. The hardened vice jaws are interchangeable and reversible. There is a depth stop for small diameter work. Coolant is supplied from an electric pump mounted in the main casing and controlled by a rotary selector switch.

Fig. 1. Edgwick Junior threading machine
Alfred Herbert Ltd.

Tube bending machine

A new high speed hydraulic production tube bender is illustrated in Fig. 2. It has been developed by Chamberlain Industries Limited, Staffa Works, Leyton, London, E.10, in conjunction with Walter P. Hill Inc. of the United States of America. The machine is designed to handle both tubes and sections, and will be available in four capacities. The smallest is shown in the illustration. It is suitable for bending 1 in diameter 16 gauge copper tubing, and is also capable of occasional bends on work of double the section modulus. The work is bent cold and unloaded over a conventional former, and the bending operation is automatic with each loading.

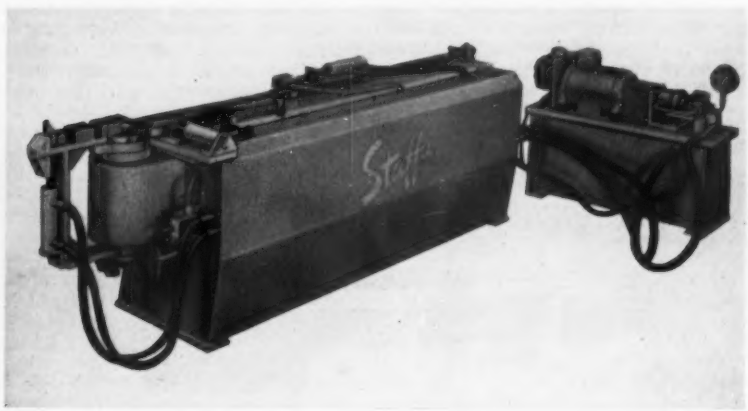


Fig. 2. Staffa hydraulic tube bender
Chamberlain Industries Ltd.

To minimize vibration and to simplify maintenance, the unit for supplying the hydraulic power is set apart from the machine. The power unit consists of a welded steel plate assembly that houses an oil reservoir of 18 gallons capacity. A 4 h.p. motor is mounted on the top plate of the assembly. It is coupled to a vane pump that is designed to deliver five gallons of oil per minute at a working pressure of 500 lb/in^2. Normally, the machine uses a much smaller volume of oil than is supplied by the pump and in order to maintain a constant oil supply, surplus oil passes through a relief valve back into the tank.

The machine itself has a rigid main frame of welded steel plate with all the electrical equipment and the hydraulic valve for controlling the operation and automatic sequence arranged along one side in a readily accessible position. A hydraulic actuator assembly at the front end of the main frame has a vertical shaft on the top of which is mounted the swinging head carrying the former round which the tubes are bent. The main driving shaft of the actuator is carried in long phosphor-bronze bushes fitted with sealing rings. A single vane is fitted into a deep key-way in the shaft, and a bulkhead

Fig. 3. BarnesdriL electronic honing machine
Gaston E. Marbaix Ltd.

divides the actuator chamber into two compartments. A sleeve mounted over the main shaft and the inner part of the vane reduces the swept volume of the cylinder and increases the speed of operation by increasing the mean effective radius. Separate fluid inlets and outlets are provided in the body adjacent to the bulkhead.

The body of the actuator is supported on a heavy bracket bolted on the end of the machine. A roller bearing on an extension at the top end of the actuator shaft and a ball bearing on the extended lower end provide the mountings for the swinging head frame. The length of arc through which the head swings in the bending operation can be set to the angle to which the tube is to be bent. To facilitate setting, an index plate with tapped holes at 15 deg intervals round its circumference is attached to the lower end of the swinging head frame. A stop, quickly inserted in the required hole, by contact with a switch serves to arrest automatically the bending movement by cutting-off the supply of fluid to the actuator chamber. For fine setting and to obtain angles between the 15 deg setting the contact pad of the switch can be adjusted over a short length.

A hydraulic ram mounted on the rear vertical member of the swinging frame has a wedge on its piston. This wedge operates a clamp that serves to hold the tube against the centre former during the bending operation. Another hydraulic ram fitted to the side of the machine operates the thrust block of a moving guide that engages the trailing part of the tube to keep it straight during the operation. The guide is supported through rollers on the thrust block so that it can move freely along its axis and at the same time provide support for the tube as the work advances over the mandrel. A wire rope attached to the rear end of the guide passes over a pulley and has a weight attached to its free end. When, at the end of a bending operation, the pressure of the thrust block is removed from the moving guide, the weight on the rope comes into effect to retract the guide ready for the next cycle.

If short lengths of tube are to be bent, the machine can be arranged for fully automatic operation. The tubes are loaded into a hopper above the machine and the feed mandrel is mounted on the rod of a long stroke hydraulic ram. At the start of the working cycle the mandrel moves forward to pick up the lowermost tube in the hopper chute and then carries it on for the normal bending sequence. A separate ejector ram is fitted to remove the bend tube from the swinging head. When this ram retracts after the ejection stroke, the mandrel is automatically retracted and the pick-up cycle restarted.

Electronic honing machine

A new type of BarnesdriL electronic honing machine is shown in Fig. 3. It has been installed at the works of the Burgess-Norton Manufacturing Company for honing gudgeon pins. The machine is fully automatic with automatic hone feed and an individual feed for each spindle. Some pins are honed both before and after hardening, others only after hardening.

The outstanding feature of this machine is the high rate of output that can be obtained while at the same time the work is produced to close dimensional tolerances with a high degree of surface finish. For example, in a green honing operation on a pin with a bore 0·9679/0·9688 in diameter × $4\frac{1}{8}$ in long, 0·003/0·004 in of stock is removed and with "plugmatic" automatic sizing the variation in diameter from bore to bore is within 0·0005 in. The output at 80 per cent efficiency is 192 pins per hour.

After hardening this pin is again honed. At the finish honing approximately 0·001/0·002 in of stock is removed. The surface finish obtained is in the order of 10-15 microinches R.M.S. Once again "plugmatic" automatic sizing is employed and the variation in diameter from one bore to another is within 0·0005 in. Taper from end to end and ovality are maintained within 0·0002 in. At 80 per cent efficiency the output is 208 pins per hour. Gaston E. Marbaix, Ltd., Devonshire House, Vicarage Crescent, London, S.W.11, are the British agents for these machines.

Lunzer rotating centres

A. A. Jones and Shipman Ltd., Narborough Road South, Leicester, have extended the range of J. and S. Lunzer rotating centres to cover Morse taper sizes Nos. 1 to 6 and with parallel shanks from $\frac{3}{4}$ in to $2\frac{1}{8}$ in. A parallel shank centre is shown in Fig. 4. Each size is made in the full series of spindle points, including female, tube models, and "reduced point" models for copy turning and similar work.

The tools are designed for exacting work on lathes and grinding machines, and several new features are incorporated. Heavy radial and thrust loads are carried in three bearings, carefully selected to give maximum support to the long but substantial spindle. The main bearings are pre-loaded, with a taper roller bearing carrying the thrust and sharing radial loads with an angular contact bearing. At the tail-end of the spindle there is a third bearing, which, dependent upon the size of the shank, is either a precision replaceable steel-backed thin-wall lead bronze bearing, or a needle roller bearing, and for the two largest models, two angular-contact ball bearings pre-loaded back to back.

Particular attention has been paid to the seal, which is made in a patented four-stage design. It positively throws out any coolant and grit that may

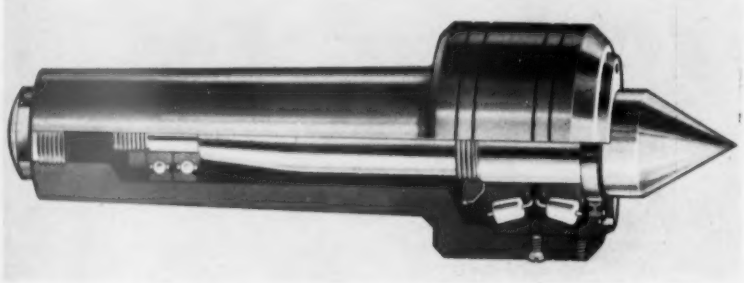


Fig. 4. Lunzer rotating centre
A. A. Jones and Shipman Ltd.

penetrate the close running clearances of the spindle. This is effected by means of an internal thrower-lip and a gutter formed in the cap in conjunction with four draining holes. A special two-lip neoprene seal fitted in the cap prevents entry of foreign matter from the gutter and loss of oil.

An interesting new development, originated in Switzerland, has also been incorporated. Its purpose is to prevent chatter and deflection at the neck of the taper shank when heavy loads or interrupted cuts are being dealt with. A steel ring is mounted to fit between the shoulder of the rotating centre housing and the face of the tailstock ram to prevent deflection of the housing under heavy loads. These steady-rings are supplied oversize on thickness, so that the user may face the ring down to suit the exact gap between the housing and the ram. For use, the machined ring is placed over the taper shank, and the rotating centre is then rammed home in its seating.

Co-ordinate boring and milling machine

A completely new conception underlies the design of the Bemag KBF-2 co-ordinate boring machine illustrated in Fig. 5. This machine, which has an accuracy approaching that of a jig borer, is designed and built by Berliner Maschinenbau-Actien-Ges., formerly known as L. Schwartzkopff. Drilling, boring, and milling operations can be carried out with great accuracy without needing any form of jig and using a minimum of operating elements.

The construction is somewhat unusual and is such as to give maximum rigidity, with easy access to the working area so that large workpieces can be readily handled. The spindle head is arranged to move transversely on a saddle, which in turn can be traversed longitudinally on a substantial bridge casting. Provision is made for 47¼ in transverse and 31½ in longitudinal movement. The spindle quill has a vertical movement of 13½ in. Furthermore, the "T" slotted table can be power adjusted vertically to a distance of 16 in. At the end of the power adjustment the table is automatically clamped.

When the spindle is in the boring position, all the slides, including the table slide, are automatically locked hydraulically. The hydraulic system also provides steplessly variable feeds from 0 to 4 in per minute for milling and rapid traverse at a rate of 157 in per minute. It is possible to operate the machine on an automatic cycle of quick approach, feed and rapid return.

The most interesting and important feature of the design is the arrangement by which accurate co-ordinate settings are rapidly obtained. These settings are effected by moving two groups of counter wheels on the spindle head, which controls two groups of end measuring rods. One group is for transverse and the other for longitudinal movement. The digits of the measurements are set up on dials similar to those of a calculating machine. On the machines made for the English market there are six digits in each group arranged to give increments of 0·0002 in. Provision is made for pre-selection; in other words, while one bore is being machined the settings can be made for the next spindle speed and spindle feed. When the spindle has been removed under power from the bore, merely pressing a button causes the next required combination of built-in end measures to be set up. Guaranteed accuracy is plus or minus 0·0008 in, although much closer measurements can be obtained. The precision measuring rods are grouped in six magazines, are totally enclosed and are never touched by hand.

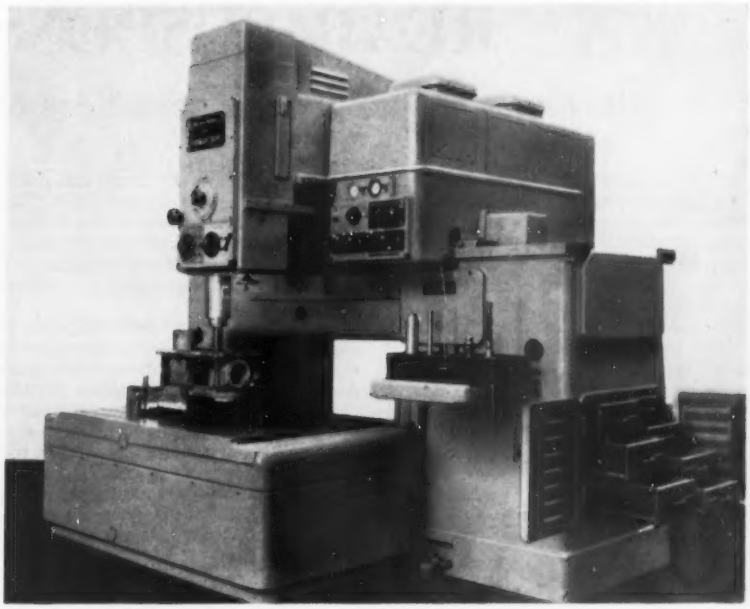


Fig. 5. Bemag KBF-2 co-ordinate boring and milling machine
Rockwell Machine Tool Co. Ltd.

An extremely simple machine control is employed and the push buttons are interlocked in such a manner that it is impossible to select a wrong movement, thus eliminating the possibility of damage to the machine or the work. For example, it is impossible to operate either the longitudinal or transverse movement while the spindle is ascending or descending. Retraction of the spindle from a finished hole takes place under power and at increased speed. The boring tools can be changed only when the spindle is in the correct position. Not only can the co-ordinate settings be pre-selected; pre-selection is also possible for milling feed, boring feed and spindle speed. The depth of bore can be automatically limited.

This machine can be fitted with additional equipment that allows automatic co-ordinate setting to be obtained from a punch car. This is intended for repetition work. When this equipment is fitted, the machine is equally suitable for single piece, batch or mass production for a wide variety of components. Because of the many outstanding features of this machine, the sole British agents, Rockwell Machine Tool Co., Ltd., Welsh Harp, Edgware Road, London, N.W.2, have arranged to import one; it is expected about the middle of May, so that all interested persons can inspect it.

A NEW TRACTOR

A 150 H.P. four - wheel tractor has been announced by the Caterpillar Tractor Co., Peoria, Illinois, U.S.A. It is called the DW15 and is powered by a Cat six-cylinder diesel engine that produces 150 h.p. at 1,800 r.p.m. The engine has aluminium alloy pistons with cast-in iron band backing for the compression ring. Chrome-nickel steel heat plugs are incorporated in the pistons to give increased service life. A triple duty oil pump is fitted to provide positive lubrication on the steepest grades.

The standard transmission gives double speed ranges, with 10 forward speeds up to 24 miles per hour and two reverse speeds up to 3·3 miles per hour. Optional final drive gears make speeds up to 31·3 miles per hour possible. The large capacity wheel brakes are pedal operated and have compressed-air boosters. When the brakes are applied, those on the pulled unit are automatically actuated just before the prime mover brakes take hold. The flywheel has an air booster that reduces clutch pedal pressure during engagement and disengagement.

REAR SUSPENSION

An Experimental Independent Rear Suspension System

IT is generally recognized that independent rear suspension has a number of advantages as compared with orthodox, through axle types. Among these advantages are: reduced upsprung weight, which tends to give better ride and road holding characteristics; the rear brakes can be placed where they will be cooled by the air flow under the vehicle, instead of being shrouded by the wheels and wheel arches; and propeller shaft torque effect, tramp, brake hop and power hop are eliminated. The main disadvantage is that independent rear suspension is almost invariably more expensive than conventional layouts.

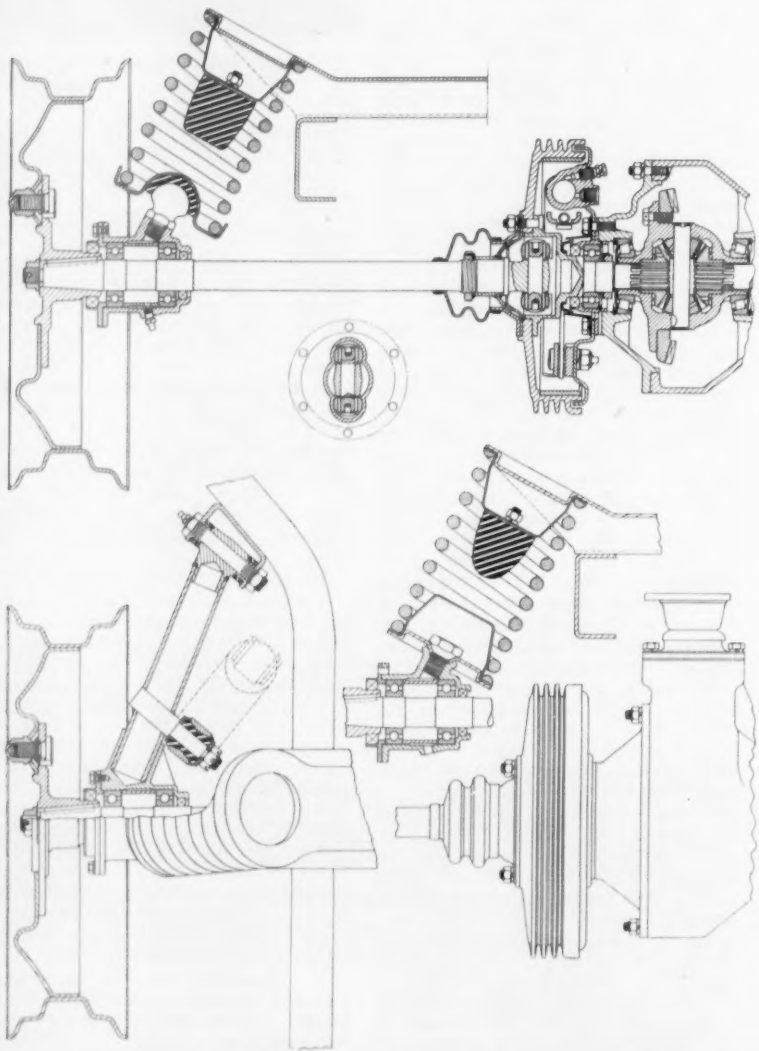
However, with the advent of automatic gear shift controls, it is possible that more attention will be devoted to the problem of rear suspension. This is because there are advantages to be gained, notably so far as economy of body space is concerned, from mounting the gear box and final drive in a common casing at the rear. With such an arrangement, independent rear suspension would be attractive.

The Société des Fonderies de Pont-a-Mousson, 91, Avenue de la Liberation, Nancy, have endeavoured to overcome the disadvantage of high cost associated with independent rear suspension arrangements by designing a system in which the number of extra components, such as universal joints, links and pivots has been reduced to a minimum. The layout is not unlike the Lagonda rear suspension, except that a coil spring is employed instead of a torsion bar. In addition to having inboard mounted brakes, the system has two noteworthy features, namely, a single radius arm is employed to control the wheel movement, and only one universal joint is employed on each side. In other words, the layout is virtually of the swing-axle type. From the illustration, it can be seen that the axis of the radius arm pivot intersects that of the final drive shaft at the centre of the universal joint. This centre is positioned about 18 in, measured horizontally, from the centre of contact of the tyre with the ground and about 6 in from the longitudinal axis of the chassis.

A fairly conventional differential-gear unit is carried in two taper-roller bearings in a casing that is divided longitudinally in a plane offset to one side of the nosepiece. Spigoted into each side of the casing is a housing for an oil seal and a ball bearing supporting the final drive shaft. This housing is secured, together with the brake back plate, by a number of 8 mm diameter set-bolts. The cup component of a Detroit-type universal joint is formed on the end of the short final drive shaft, and round this cup is a flange to which are secured the brake drum and outer component of the spherical joint. The inner component of the spherical joint is welded to a sleeve round the swing-axle. This sleeve is pulled against a collar on the axle by a ring nut locked by a tab washer.

The outer end of the swing-axle is carried in two ball bearings spaced with their centres approximately 2 in apart in a housing rigidly attached to the radius arm. Oil seals are carried in each end of the housing: the inner one bears on the shaft and the outer one on the wheel hub, which is tapered and keyed on the end of the shaft. The radius arm is spigoted into a socket formed in the bearing housing. It is a tube about $1\frac{1}{2}$ in outside diameter by $\frac{5}{32}$ in thick, and is drilled to carry the welded-in trunnion mounting for the telescopic shock absorber. Spigoted and welded into the other end of the tube is the pivot forging.

Two different types of spring mounting are shown. With one, the lower spring pan has a hemispherical indentation pressed in its centre and is rubber mounted on a ball-fitting screwed into the bearing housing. This arrangement allows a certain amount of flexibility and helps to relieve the spring of extra strain imposed on it as a result of misalignment of its upper and lower ends when rigidly mounted spring seatings are employed.



The experimental rear suspension system and an alternative spring mounting

AKULON

A Nylon-Type Material that may have Many Applications in Engineering

AKULON is the trade name for a material of the nylon type. It is manufactured by Algemene Kunstzijde Unie N.V., of Arnhem, Holland, and distributed in the United Kingdom by The Hercules Powder Co., of 140, Park Lane, London, W.1. Four grades are currently available, Akulon M2 and K2, which are the more rigid types, and M10 and K10, the more flexible forms. The M grades are especially suitable for extrusion and are superior so far as wear resistance and toughness are concerned. Although the K grades are slightly less hard wearing and tough than the M materials, they are nevertheless suitable for many applications, particularly when the injection moulding process is used in manufacture. Some of the properties of these materials are given in the accompanying table.

This material is not suitable for indiscriminate use in engineering but it has certain properties that make it particularly attractive for some applications. These include light weight, corrosion resistance, homogeneity, resilience, fatigue resistance, low coefficient of friction and good wearing properties. Furthermore, it is easily adapted to mass production methods.

When comparing the cost per pound of this material with that of steel, it is necessary to take into consideration the fact that Akulon has a specific gravity of approximately one-seventh of that of steel. An important feature of Akulon is that by comparison with other plastics materials, it has a relatively high melting point and only a small range of temperature immediately below the melting point in which it is too soft for normal applications. It becomes soft at 210 deg C and the melting point is 220 deg C.

PROPERTIES OF AKULON

	M 2	M 10
Specific gravity	1·13	1·13
Yield strength, lb/in²	±9,250	—
Ultimate tensile strength, lb/in²	±37,000	±31,400
Izod impact strength	±2·3	±4·7
Modulus of elasticity, lb/in²	462,000	214,000
Dielectric strength, V/mm	18,000	5,200
Coefficient of thermal expansion/100 deg C.	10×10^{-5}	10×10^{-5}
Rockwell hardness, R-scale	115	112
Melting temperature :		
deg C	220	220
deg F	428	428

Production methods

Components of Akulon can be made in a number of different ways. They can be extruded, and the material is supplied in granules for this purpose. These granules are relatively hard in the cold state so, if continuous high-speed production is to be maintained, slight modifications have to be made to the ordinary type of extruder screw, such as is used in machines for processing P.V.C. and other thermoplastics. The basic principle of the extruder machine is as follows. The granules are hopper-fed into a tube in which is operating a screw that pushes them through the heated portion of the tube, where they are melted, and thence to the extrusion die. Rapid cooling of the extrusion is desirable if discoloration and oxidation are to be avoided. This is best done by extruding directly into a bath of cooling water at room temperature.

The injection moulding process is similar except that instead of the screw, a plunger is used to force the granules through the heater tube and into the mould. Each shot, as it is called, of the plunger takes from ¼-1 minute. However, the moulds can be so constructed that a number of components, possibly as many as twenty, can be made simultaneously from one shot. Although the moulds are usually relatively expensive, their cost can be economically amortized if production is on a large scale. This method is generally suitable for the manufacture of small components When larger parts have to be made, centrifugal casting is often employed.

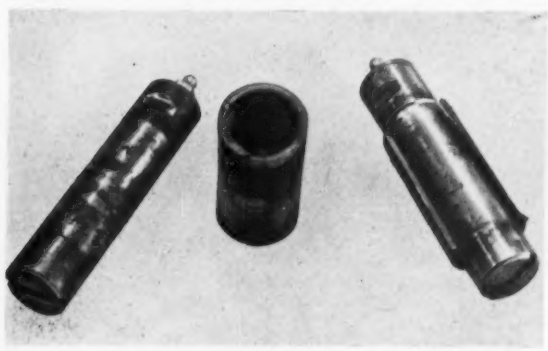


Fig. 1—The Akulon bush and its pin, on the left, and the phosphor bronze bush and pin, on the right, were both used for the same period of time in spring eyes on the same commercial vehicle

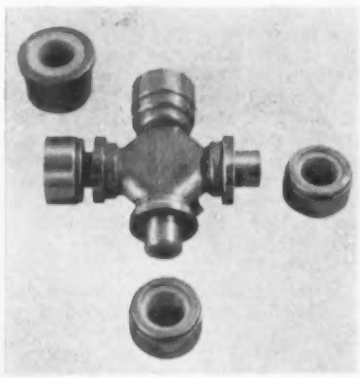


Fig. 2—A universal joint spider fitted with Akulon bushes

Machining operations can also be performed on the material. Bar stock is available for the manufacture of machined components, which are sometimes used for experimental and prototype work. Because of the limited thermal conductivity and low modulus of elasticity of Akulon as compared with metals, care must be taken to maintain the tools in good condition and it is recommended that a cooling medium be applied. For turning tools, the following angles are specified: end-relief angle 15-20 deg, back-rake angle 5 deg, side-rake angle 4 deg, side-relief angle 5 deg. A smooth surface is obtained even when a large depth of cut is taken, so rough pre-turning is unnecessary. Carbon steel tools are satisfactory, provided the working surfaces are polished. However, high-speed steel is preferable for quantity production on automatic lathes. In general, a turning speed of about 1,000 ft/min and a feed of about 1·1 ft/min are suitable when the depth of cut is slightly less than 0·2 in.

Milling should present no difficulties provided the clearance and rake angles are similar to those given for turning, and high speeds and light feeds are applied. It is preferable to use a cooling medium. Akulon can best be sawn with a band-saw which, because of its great length, readily dissipates the heat

generated. Saws with 4-6 teeth per inch are recommended. The set of the teeth should be fairly large, otherwise high temperatures might be developed and cause a gummy surface on the Akulon.

For drilling small holes, it is recommended that a twist drill with the point ground eccentrically should be used. In this way, the hole diameter, of course, is made slightly larger than that of the drill so that less heat is generated. It is advisable to lift the drill out of the hole from time to time to ensure satisfactory removal of the swarf. When holes have to be drilled close to one another and cannot be drilled simultaneously, it may be necessary temporarily to plug the holes, one by one as they are drilled, to avoid distortion during subsequent drilling. The feed should be reduced as the depth of the hole increases. With a 3 mm drill, satisfactory results are obtained at speeds of 2,000-3,000 r.p.m.

Straight reamers give an uneven surface, but helical reamers are satisfactory. With these tools, as with the drills, the cutting and clearance angles should be the same as those quoted for lathe tools. Threading and tapping present no difficulties.

Applications

Because of the resistance to wear, low coefficient of friction and the resilience of this material, it has given good service when used for bearing bushes. Fig. 1 shows two shackle pins and bushes. One of the bushes is of phosphor bronze and both the bush and pin are badly worn. On the other hand, neither the other bush, which is made of Akulon, nor its pin have been worn sufficiently to justify replacement. Both pins and bushes were fitted to the same vehicle, one on each side, and were run simultaneously for the same period. Bushes of this material have also been used as replacement parts for the needle roller bearings of the universal joints in the transmission system of the front-wheel-drive Citroen cars. A universal joint spider with nylon bushes is shown in Fig. 2.

Fig. 4—Silent running is an advantageous feature of sliding door rollers made of nylon-type material

The good wearing properties of Akulon are probably accounted for by the fact that it has a low melting point and does not easily oxidize or combine chemically with other substances. It is well known that when two surfaces rub together, only the peaks of the asperities contact, and extremely high temperatures are developed and they melt. Because of the low melting point of the Akulon, it is probable that the asperities rapidly wear down and contact then takes place over a larger area so that the true bearing pressures become lower and so do the temperatures developed. Moreover, there is no tendency for the nylon to weld to the metal of the pin nor does it corrode and form abrasive particles between the rubbing surfaces. The combination of these features is undoubtedly the reason for the low coefficient of friction between nylon-type materials and steel.

Under conditions of light load and low rubbing velocity, there is no need for any lubrication. Should the lubricant dry out, the Akulon, even when more heavily loaded, will operate satisfactorily for fairly long periods. In fact, the main function of the lubricant is to assist in the transfer of heat from the surface of the Akulon to the surface of the metal, whence it can be conducted away. Heat dissipation is the main problem with Akulon bearings because the thermal conductivity of the material is low.

Apart from wear resistance and low coefficient of friction of the material, it has other properties that make it suitable for these applications. One of these is its ability to absorb vibration and shock, and another is that it does not suffer from fatigue as do metals. It can be assembled with extremely small running clearances but in these circumstances, it is usual to incorporate a groove in the bearing surface as in Fig. 3, to allow for any expansion or spreading that might occur. Another advantage of this material is that it tends to reduce the amount of noise transmitted to the structure. For this reason, it is also used for rollers on sliding doors, Fig. 4. Because of the resilience of the material, the rollers can be assembled so that they bear fairly tightly on the runner to eliminate rattle. Possibly the use of rollers of this type would prevent rattles developing in sliding doors fitted to commercial vehicles.

Akulon is also used for gears. If the gear diameter is large, it is usual to make the disc and boss of steel and to fit a ring gear of the nylon-type material, since this is the most economical arrangement. However, small gears are frequently made entirely of Akulon, particularly when they rotate on a shaft, because this arrangement obviates the need for bush-type bearings. It is claimed that in many applications, the best wear resistance is obtained when both gears of meshing pairs are of Akulon.

However, under heavy loading and rubbing contact, such as occurs with worm drives, it is desirable to have one gear of Akulon and the other of steel to carry away the heat generated. Obviously, it is the worm that should be of steel. Under lightly laden conditions, lubrication is not necessary. For this reason, gears of nylon type material are particularly suitable for instruments. When Akulon gears mesh with steel ones, the tooth loads are more evenly distributed because of the resilience of the softer material. Therefore, methods of stress calculation employed for metal gears will give high factors of safety when nylon gears are employed.

Fig. 5—These eight components for electrical equipment were made with one shot of the injection moulding machine

It has been found that cables coated with Akulon have a useful life of approximately double that of uncoated ones. Coated cables are particularly suitable for Bowden-type controls because of their low friction characteristics. Akulon can be sprayed on to metal components to protect them from corrosion. The material is also suitable for application to electrical components because of its good insulating properties and resistance to corrosive influences. Fig. 5 shows a group of eight terminal block casings made by one shot of the injection moulding process.

Fig. 3—A groove has been cut in this Akulon bearing to allow for dimensional changes

GOODS VEHICLE CABS

Higher Standards of Comfort, Appearance and Efficiency

MARKED changes have taken place in the design of drivers' cabs for goods vehicles in recent years, as is obvious from an examination of the exhibits at any truly international motor show. The greater power-to-weight ratio of the average goods vehicle of to-day, compared with those of 15-20 years ago, together with the improvement in suspension, steering, and braking which have been achieved, have increased the speed potential of the goods vehicle to the point at which the designer must appreciate the importance of providing the driver with first class visibility, a comfortable seating position, and some degree of protection from engine noise and heat. Accessible controls are of equal importance, so that long hours in the cab do not provoke undue fatigue. Also vital, especially from the operator's point of view, is the question of the appearance of the cab, which must be modern, since so many goods vehicles are intended as much as mobile publicity vehicles, as carriers of goods, while the panelling must be devised so as to make repair of damaged areas cheap and simple, in view of the frequency and likelihood of damage in congested streets and loading bays.

The recent Geneva Show contained several goods vehicle cabs which could be considered as excellent examples of current trends in cab design and in production engineering. While many of the goods vehicles displayed were equipped with coach-built, or small series production cabs, these, too, revealed numerous detail refinements in structure and equipment which were worthy of note, especially as the specialist cab builder has to turn out his product at a competitive price.

The Citroën normal control 2- and 5-ton goods vehicles have both recently been equipped with a new cab of markedly more modern appearance than the one which has been used on these chassis since the 30's. Nevertheless, this pressed steel design must be one of the simplest modern cabs produced to-day, because so few deep drawings are employed in its structure. The mudguards and the bonnet are, in fact, the only components which require deep dies, the rest of the bonnet and cab being built up of a comparatively large number of single curvature panels. Even the front panelling comprises three main pressings, the outer ones containing the headlamps, and the broad central one the decorative radiator grille. This is bolted to the two side sections, so that it can be removed for attention to the radiator or for removing the engine.

A comparatively small number of large and complex pressings make up the International cab

The scuttle is a large flat pressing to which are spot welded the side walls of the engine bay, on top of which two small, almost flat "cat-walks" are similarly attached. The mudguards have deep up-standing flanges, the reverse of the normal practice, and these are spot-welded to the cat-walks, thus making a notably simple, if not particularly attractive, method of attachment. The windscreen framing, consisting of simple pans for the two windscreen panels, is welded to the scuttle, and incorporates the fore-peak of the roof. The back of the cab is another single pressing, dished for rigidity, and the roof structure is completed by a single curvature-section which unites the front and rear of the roof. The flanges of the centre section add rigidity to the cab, as do the diagonal lining panels which are welded vertically between the back and sides of the cab. The doors are built up on a framing that consists of two rolled channel sections, back to back; above the waist line, a single channel section is employed for the window framing, a practice seen in some of the more expensive private cars. The cab

Except for the mudguards and bonnet top, all the pressings in the Citroën normal control cab are simple

Elements of stressed skin construction are found in the chassisless Citroën H 1200 model

and bonnet are bolted directly to the chassis in the smaller model.

Monocoque construction is extremely rare in the goods vehicle field, but is employed for the smaller Citroën truck, the H 1200, which, for an unladen weight of 1,500 kg, carries a payload of 1,200 kg. The light weight and capacious body of this vehicle are obtained as a result of its unusual design, which combines semi-forward control, front wheel drive, and stressed skin bodywork. The cab is built around a large U-shaped girder positioned immediately behind the front wheels, and which has the stressed wheel boxes and the floor welded to it.

Two flat pressings form the back of the cab. They are formed at the outer edges into a channel section, and joined just below the waist line. The unusual appearance of this vehicle, with its angular engine cover, derives mainly from the corrugated panels which are employed in the doors, bonnet, and body sides. The advantages of this type of panelling are seen best in the doors. These comprise simply a plain, skeleton inside framing, and the corrugated outer panelling. The inner pressings are of channel section, so that the welded doors have a strong box-section framing. A light gauge of steel is used, but the doors have ample rigidity. The only deep drawn panel in the H 1200 is the roof.

In complete contrast, is the type of cab found on the International range of vehicles. Large complicated pressings are employed, the total making up the complete cab probably being half the number used in the Citroën. The cab and bonnet structure is mounted on the chassis on four rubber bushes. The deep mudguards bolt on to the side walls of the engine bay which are welded to the scuttle. A feature of the cab is the extremely wide, double-curved single-piece windscreen, which brings the side pillars back out of the driver's field of visibility. Underneath the windscreen, the back of the scuttle is curved over to form a curved dash panel, lipped at its upper edge. The

Outstanding visibility and complete equipment are found in the American Ford cab

instrument panel set in the dash is thus cowled by the upper projection, so that the instrument lighting causes no reflection in the windscreen at night. A similar cab, with an even greater radius of curvature on the windscreen is seen on the larger American Ford models. The frontal styling of the Ford range commands interest, because the deep bonnet is brought sufficiently far down, and the forward ends of the mudguards are turned sufficiently far around the front, to obviate the need for a complicated grille pressing.

Instead, there is a wide, but shallow, ornamental pressing, consisting of two U-shaped bars, joined in the centre by a narrow vertical brace, and rounded off at the outer edges to form housings for the head and side lamps. Although this feature demands the use of costly tools, its design is such that minor damage does not disfigure the whole vehicle. The instrument panel in this design is enclosed in a housing forming part of the dash pressing, and a full range of instruments, an ash tray and a large dash locker are provided.

Many of the Continental cabs are equipped with comprehensive heating and ventilating systems. The forward control Henschel, for example, is equipped, as standard, with a Perspex louvre above each of the side windows, which is devised to withdraw air from the cab even when the windows are closed. In this case, the engine is in the cab. The two seats alongside the driver's are adjustable for rake, and a net rack is slung under the forepeak of the roof above the windscreen to contain driver's and crew's baggage. Undoubtedly, the long distances covered by some Continental operators' vehicles account for the profusion of equipment of this type often seen.

For example, a new Mercedes Benz forward control six-tonner with the engine in the cab was provided with a large capacity heater and screen demister. The cab, built by Flückiger, had very low screens, providing excellent visibility to the front, and the swivelling quarter panels in the door windows were hinged at their rear edges, so as to draw air into the cab. To obviate draughts, a second pane of glass is hinged to the top and bottom framing of the side windows at the rear, and may be turned to deflect incoming air out again. A similar arrangement is found in the standard Mercedes cab. The Flückiger cab had a timber framing, panelled in steel, the interior being finished entirely in black crackle enamel. At the bottom of each of the doors, at the rear, a conical housing contained a large spring-loaded ball bearing, which bore on a cup in the bottom framing of the door, thus ensuring that the door would fit, even if the cab framing should twist.

A single-piece curved windscreen, of unusual width, was found on the cab of the new underfloor-engined F.B.W. In this case the cab was built up of square section steel tube framing panelled in steel.

A single piece, curved windscreen is a feature of the cab on the F.B.W. underfloor-engined, 7-8 tonner

Luxury fittings, including extractor louvres, are found in the Henschel forward-engined chassis

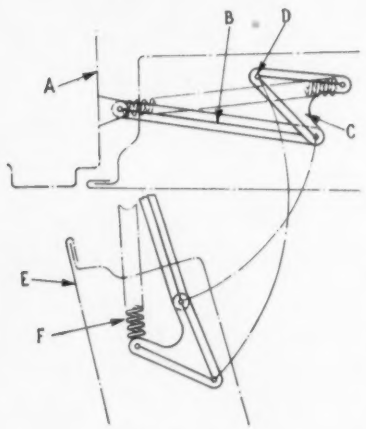
CURRENT PATENTS

A Review of Recent Automobile Specifications

Door check

ALTHOUGH primarily intended for vehicle doors, this check strap device is applicable also to bonnets or trunk lids. On a bracket secured to door post A is pivotally mounted a check arm B. The opposite end is pivoted to one arm of a triangular plate C, itself pivoted at the apex D to the door E. A coiled spring F connects the other arm of plate C to the door post bracket.

In the closed position the axis of the spring lies to one side of the pivot at D and tends to hold the door shut. In opening the door some effort is required to overcome this force and extend the spring until it can swing to the other side of the pivot at D, the plate C rotating through almost 180 deg. The door is then held resiliently in the open position. To prevent arm B and the connected arm of plate C passing over dead centre, and thereby virtually locking the door in the open position, an adjustable stop may be provided within the door. *Patent No.* 702781. *Pressed Steel Co., Ltd.*



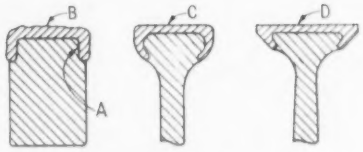
No. 702781

Reinforced exhaust valves

WHILE the reinforcement of the working face of a valve by Stellite or similar material serves a useful purpose, both upper and lower surfaces of the head and also the neck remain unprotected. A method of manufacture is described by which the reinforcing material is extended over those surfaces.

The initial cylindrical steel blank has at one end a portion A of reduced diameter over which is applied, by autogenous welding, the reinforcing material B. This blank is subjected to a first forging operation to form the spindle and roughly preform the head, as at C. After reheating it is forged in a die to final shape and closely approximate dimensions, as at D.

By suitably proportioning the reduced diameter of the initial blank and the amount of reinforcing material it may be arranged to extend the reinforcement over the neck of the valve. It is claimed that the forging operations ensure freedom from porosity in the reinforcing material. *Patent No.* 701753. *A. Teves, H. Teves and E. A. Teves (Germany).*



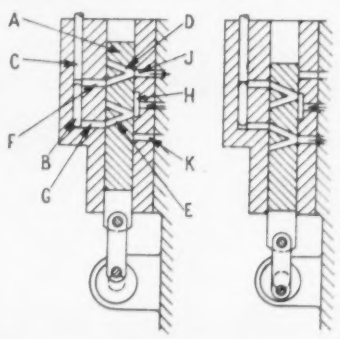
No. 701753

Metering liquid fuel

PARTICULARLY, but not exclusively, intended for the low-pressure injection of petrol, this invention provides a simple, compact and easily regulated arrangement ensuring consistently accurate measuring of the quantity of fuel to be injected at each stroke. Due to the low mass of the moving parts, operation at very high rates of reciprocation is satisfactory and a single unit may serve one, a pair or even several pairs of injectors.

A cylindrical slide valve A is reciprocated in a stationary bore by an engine-driven eccentric. In an adjacent small-diameter bore is a needle-like piston B having rounded ends and freedom to move between the end of the bore and the end of an axially displaceable regulating rod C. Transverse drillings D and E in the valve control ports F and G communicating with opposite sides of piston B. A conventional supply pump delivers fuel to recess H whence it flows, at the top of the valve stroke, through drilling E and port G to the lower side of piston B. Simultaneously, as the piston is moved upwards, fuel is displaced from the space above the piston through port F and drilling D to discharge passage J. When the valve is at the bottom of its stroke, fuel is transferred from the space below the piston to discharge passage K, as shown at the right of the diagram.

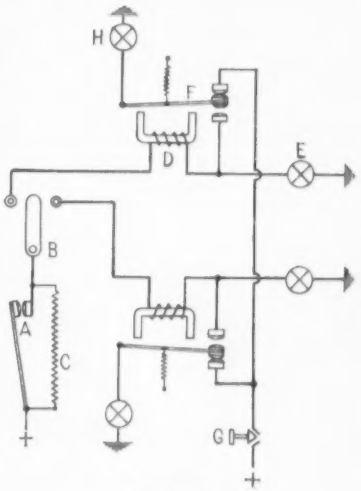
The quantity of fuel displaced is determined by the stroke of piston B which is regulated by adjustment, either manually or automatically, of the axial position of rod C. Since a supply pressure of about 0·3 atm (4·4 lb/in^2) above injection back pressure will usually be sufficient, only a low-pressure pump will be necessary for systems in which fuel is injected into the inlet passage or into uncompressed air in the working cylinder. If necessary, however, fuel at pressures up to 100 atm (1,470 lb/in^2) can be handled. *Patent No.* 702778. *Daimler-Benz A.G. (Germany).*



No. 702778

Flashing direction indicators

SINCE flashing lamps are frequently positioned closely adjacent to stop lamps, it is suggested that simultaneous operation is likely to impair the efficiency of the direction signal. This disadvantage may be obviated by using the same lamps for both signals, and incidentally saving lamps and wiring.



No. 701956

Referring to the circuit diagram, current is fed from a bimetallic flashing device A to the three-way direction switch B. The flasher is provided with a resistor C so that the current passed when open is inadequate to light the lamps but sufficient to maintain a relay in its operated position. Each selector contact of the switch B is connected to the winding of a relay coil D and thence to one pole of an earthed front lamp E. Relay armature F is normally constrained by a spring to bring its change-over contact into engagement with a back contact connected to the stop switch G actuated by the brake pedal. Armature F is connected to an earthed rear lamp H. When the relay is energized the armature F moves to break the back contact and engage the front contact.

It will be seen that by closing stop switch G only, both rear lamps are switched on continuously. When only direction indication is required, the selected relay will bring in both lamps on one side of the vehicle for flashing signals. In the case of simultaneous direction and stop signals, a continuous stop signal is given only on the side opposite to the flashing direction signal side. *Patent No.* 701956. *Scintex (France).*

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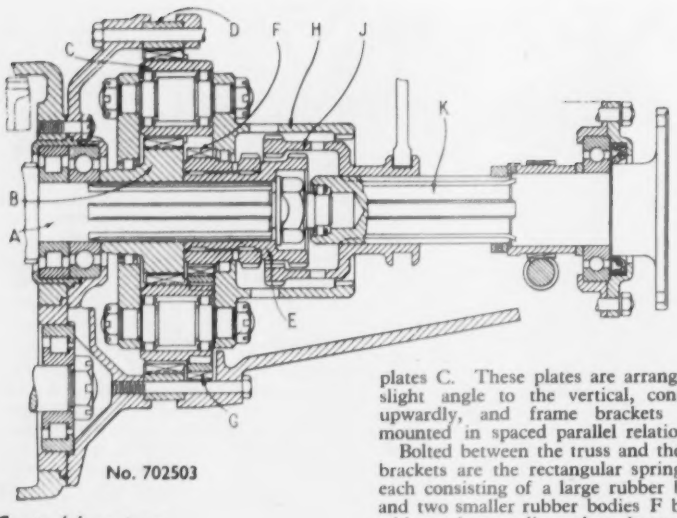


No. 702503

Coated bearings

IT has long been known that the application of a very thin layer of a soft, ductile metal to the surface of a bearing will materially reduce the time required for running-in. Electrolytic and vaporizing processes have been developed but various difficulties or disadvantages are encountered. It is cited in this connection that dimensions may be altered to an extent demanding either special or additional machining, that the deposited layer is not sufficiently adherent, that sharp edges are likely to be loosely or inadequately coated, and that vaporization requires expensive plant in consequence of the high evaporation temperature and the necessary vacuum, or reducing or neutral atmosphere.

According to this invention the deposition is made by dipping the component into a liquid salt melt containing a salt of a soft metal or salts of the constituents of a soft metal alloy. Both the co-operating parts—for example a bearing and a shaft—may be treated. It is claimed that dimensions are substantially unaltered, that the deposited metal is intimately and firmly bonded to the surface, that the layer is of the same thickness and quality throughout, and that the method is simple and the dipping time only from 0·5 to 10 min according to requirements.

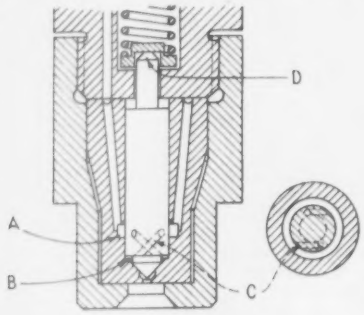
Tests have shown, it is stated, that this process confers to bearings further advantages of improved load-bearing capacity and reduced heating during operation. *Patent No.* 702272. *E. Gebhardt and G. Schrag* (*Germany*).

Shear rubber suspension

A SOFT vertical ride at low frequency is given by rubber operating in shear in this suspension system. Important objects are to provide a simple construction, low initial cost and upkeep, and elimination of lubrication. The illustration shows a rear driving or tandem axle. In another specification by the same inventor, No. 702720, is described a front axle suspension of the parallel leading link type embodying similar rubber components.

The axle housing at each end is provided with a bracket carrying a pair of rubber-bushed bearings A in which is journalled the lower tube of a fabricated truss member B comprising upper and lower tubes joined by longitudinal and transverse webs and butt-welded to end plates C. These plates are arranged at a slight angle to the vertical, converging upwardly, and frame brackets D are mounted in spaced parallel relationship.

Bolted between the truss and the frame brackets are the rectangular spring units, each consisting of a large rubber body E and two smaller rubber bodies F bonded, with an intermediate plate, between two metal plates. It will be seen that as the frame moves downwardly a wedging force is impressed on the rubber bodies. Between the rubber bodies F a pair of stops G is provided to limit relative movement. The engaging faces are V-shaped to ensure interaction and to maintain lateral alignment.



No. 702797

With an empty or lightly-loaded vehicle, axle movement is constrained by rubber bodies F but when heavily loaded the stops G prevent overstressing of bodies F and movement is resisted by main bodies E. Under heavily loaded conditions, a leverage action about the stops G may be exerted on the spring unit, tending to stress the lower body F and relieve the lower end of body E. This is compensated by simultaneously engaging wedging stops H on end plate C and the spring unit intermediate plate. The maximum force that can be imposed on body E is limited by stop J engaged by the spring intermediate plate. *Patent No.* 701623. *Hickman Industries, Inc.* (*U.S.A.*).

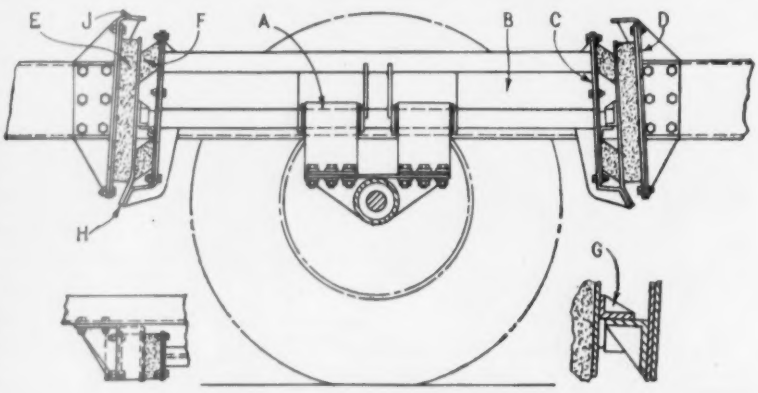
Auxiliary low and overspeed gear

THIS epicyclic gear unit, designed specifically for attachment to an existing gearbox, provides in addition to the normal direct top gear a low and an overspeed ratio. The driven shaft of the existing box forms the driving shaft A of the auxiliary unit and carries the sun wheel B driving main planet pinions C meshing with a fixed toothed annulus D. Rotatably mounted on sleeve E splined to shaft A is sun wheel F in constant mesh with secondary planet pinions G keyed to certain pinions C. Externally toothed clutch elements are formed on the rear extremities of wheel F and sleeve E and internal teeth on the sleeve H attached to the planet carrier. A clutch member J, slidably splined to driven shaft K is furnished with internal and external teeth to engage selectively the clutch elements to give (in the order of reference) overspeed, direct and low speed drives. *Patent No.* 702503. *Fodens Ltd., and E. Twemlow.*

Auto-rotation of fuel injector needle

IN fuel injectors in which the needle valve has two annular fuel chambers—the one adjacent the seat constituting a whirl chamber—connection between the chambers is commonly effected by grooves in the surface of the needle. These grooves are inimical to the production of the essential very fine fit of the needle in the guide between the two chambers. As an improvement, therefore, it is arranged that fuel can pass from supply chamber A to whirl chamber B only by way of two drillings C in the needle which are longitudinally inclined to, but do not pass through, the axis.

By transmitting the force of the closing spring to the needle with the minimum friction—for example by reducing the area of contact between the needle and the spring collar, as shown at D—the reaction force exerted by the expulsion of fuel from drillings C suffices to rotate the needle when it is lifted from its seat. The effective working life of needle and seat, it is claimed, is thereby extended. *Patent No.* 702797. *R. l'Orange* (*Germany*).



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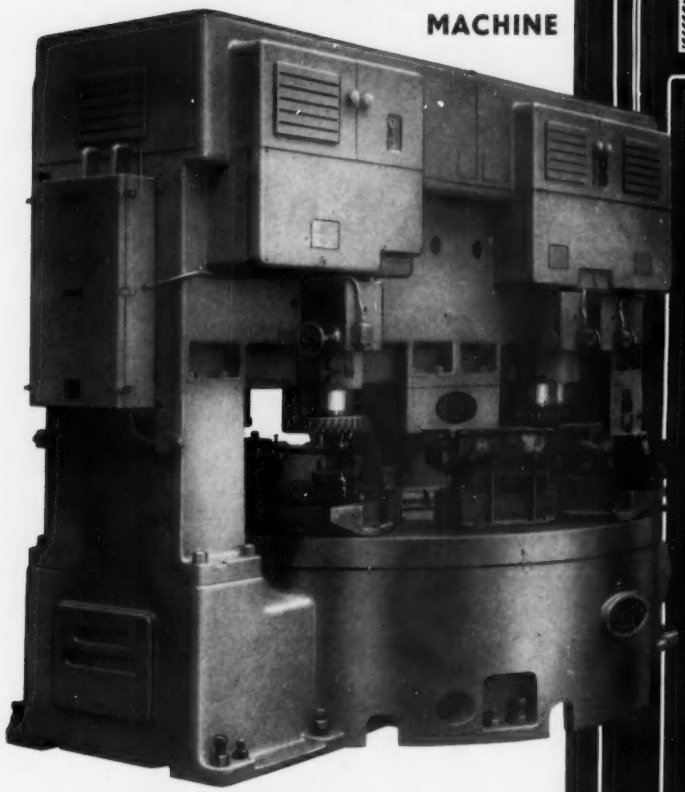

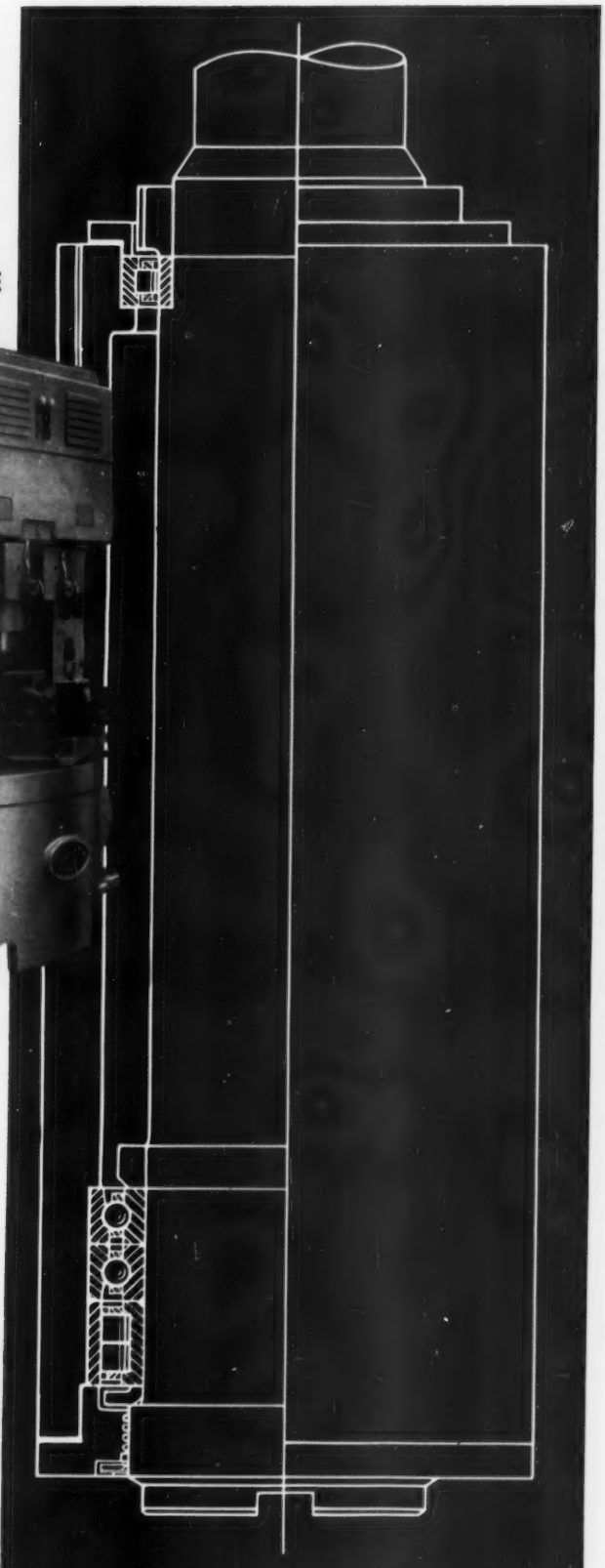

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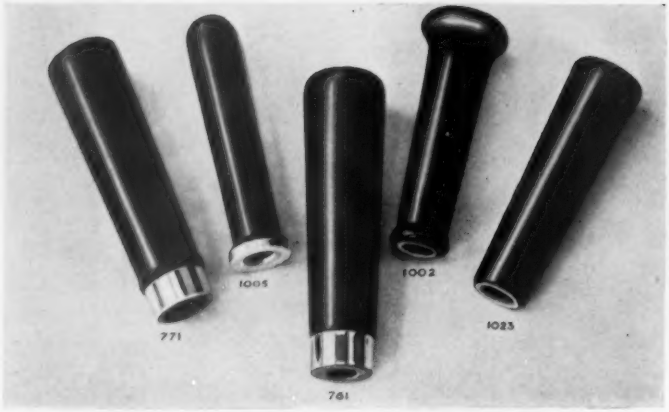

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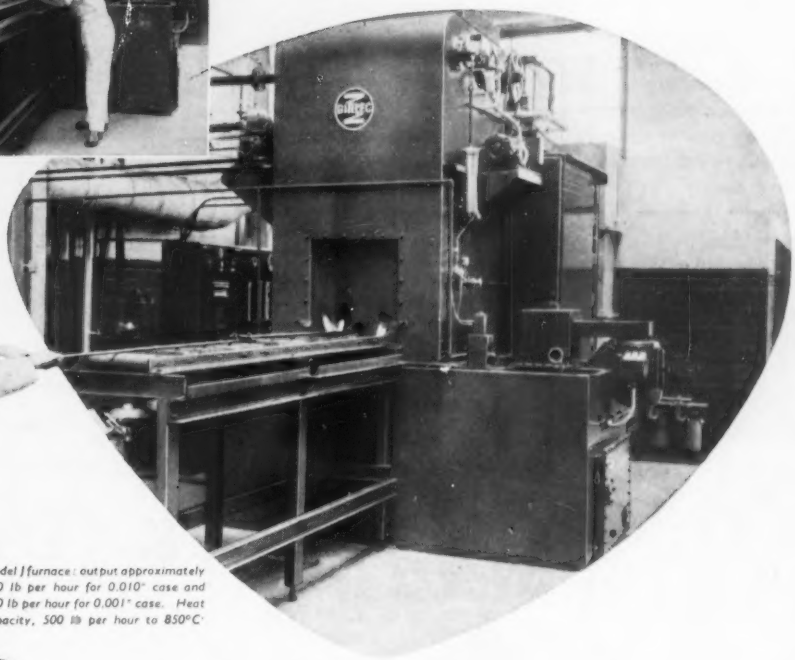

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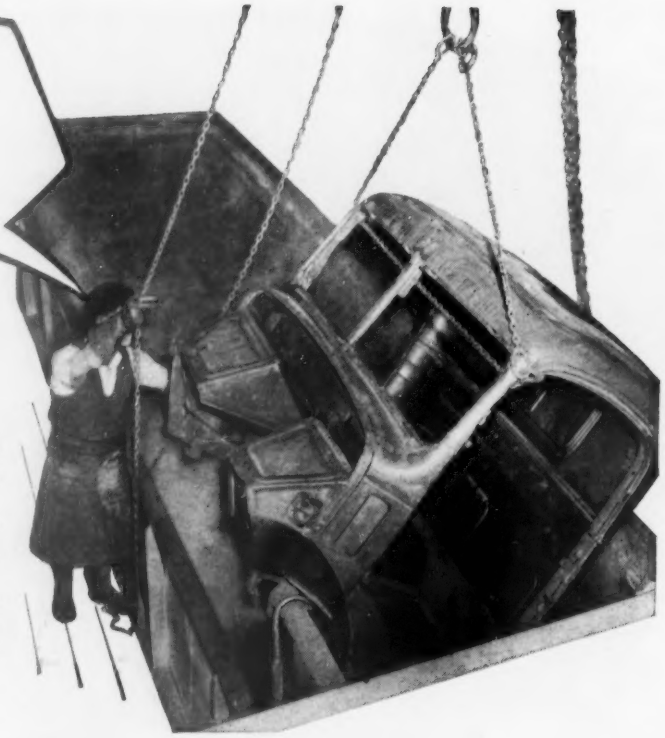

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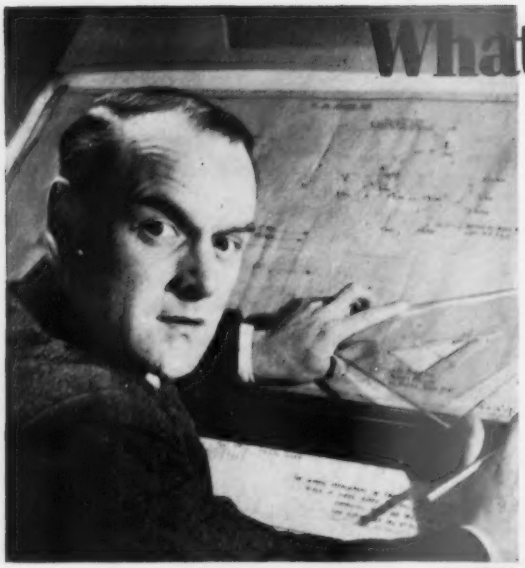

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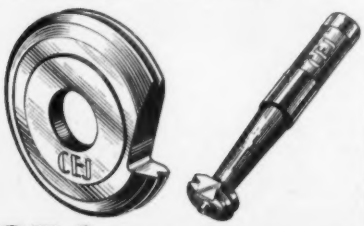

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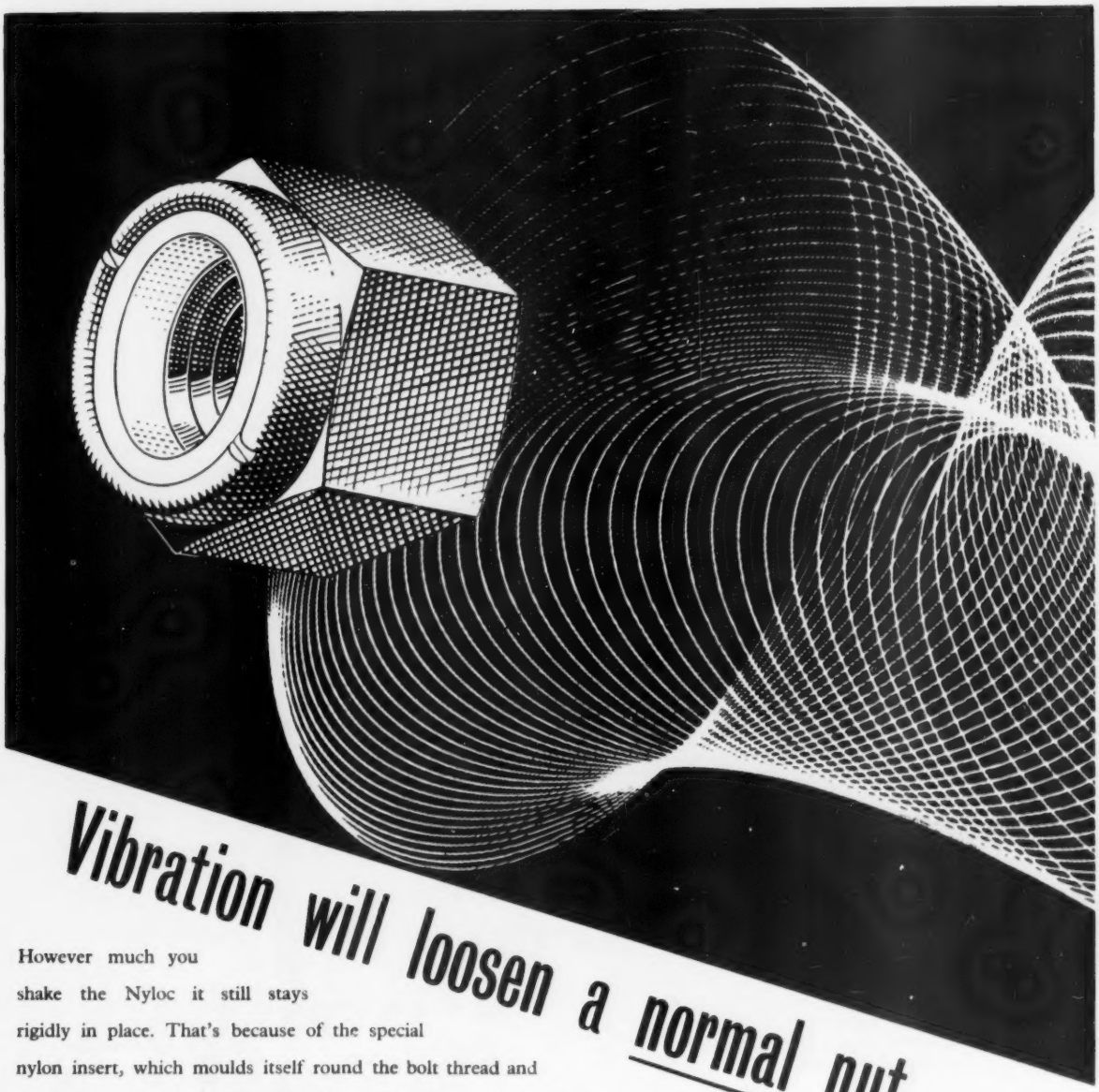

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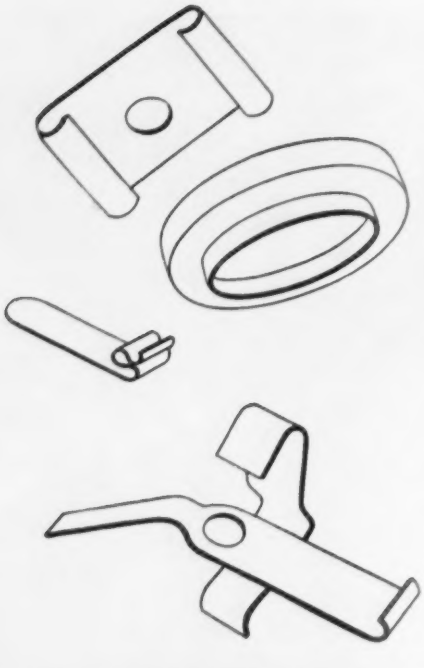

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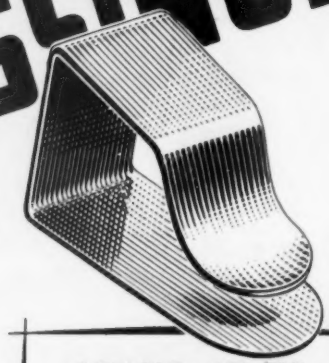

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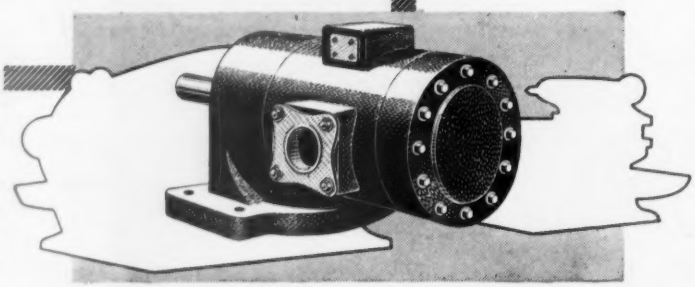

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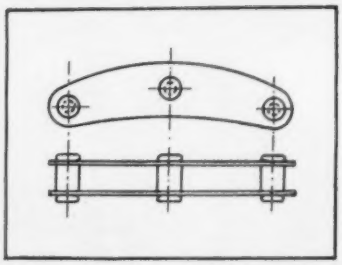

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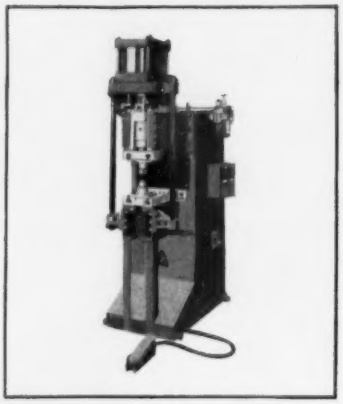

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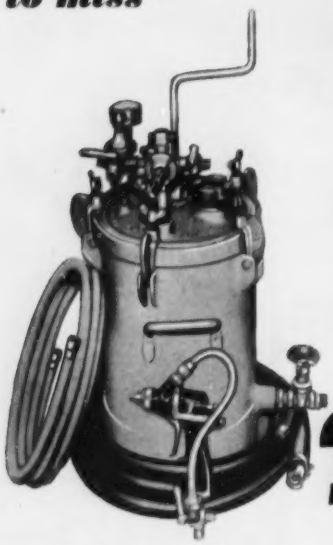

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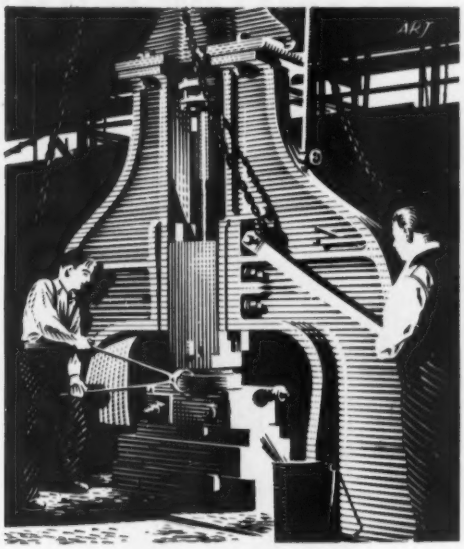

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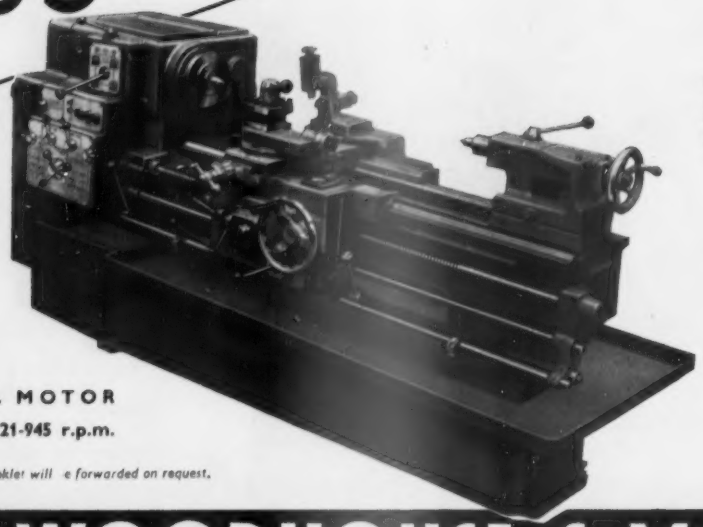

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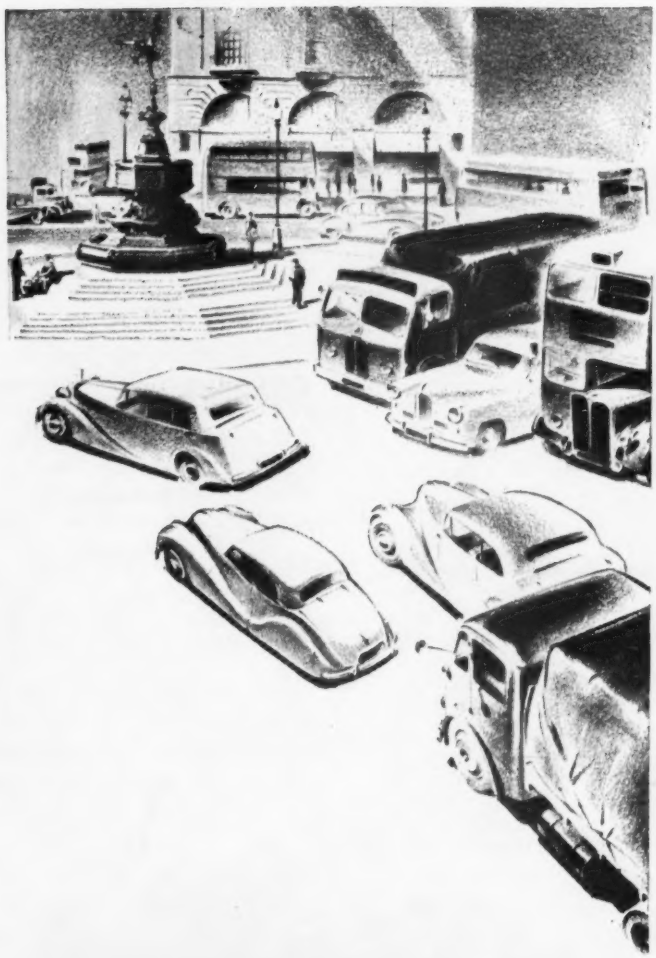

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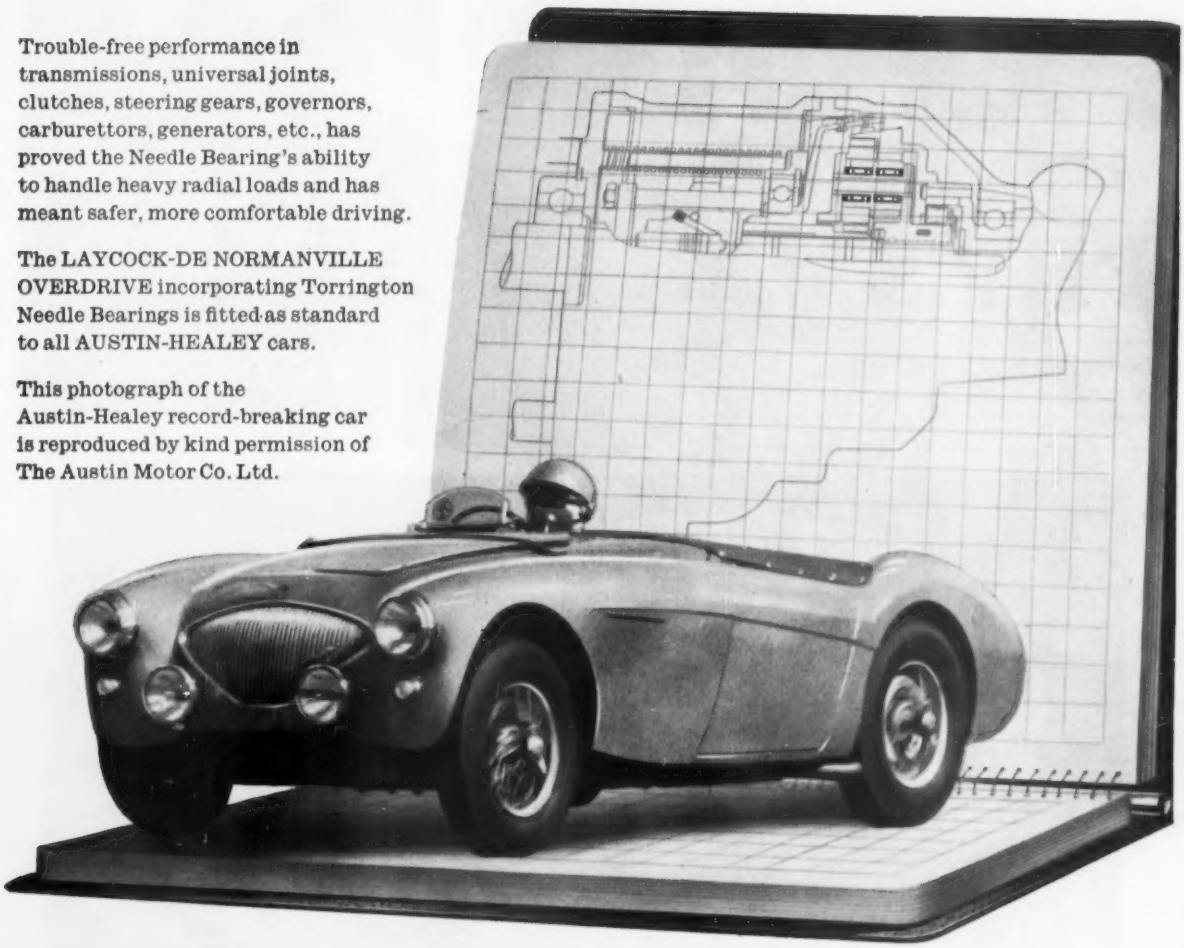

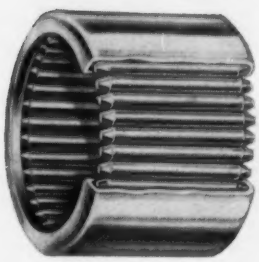

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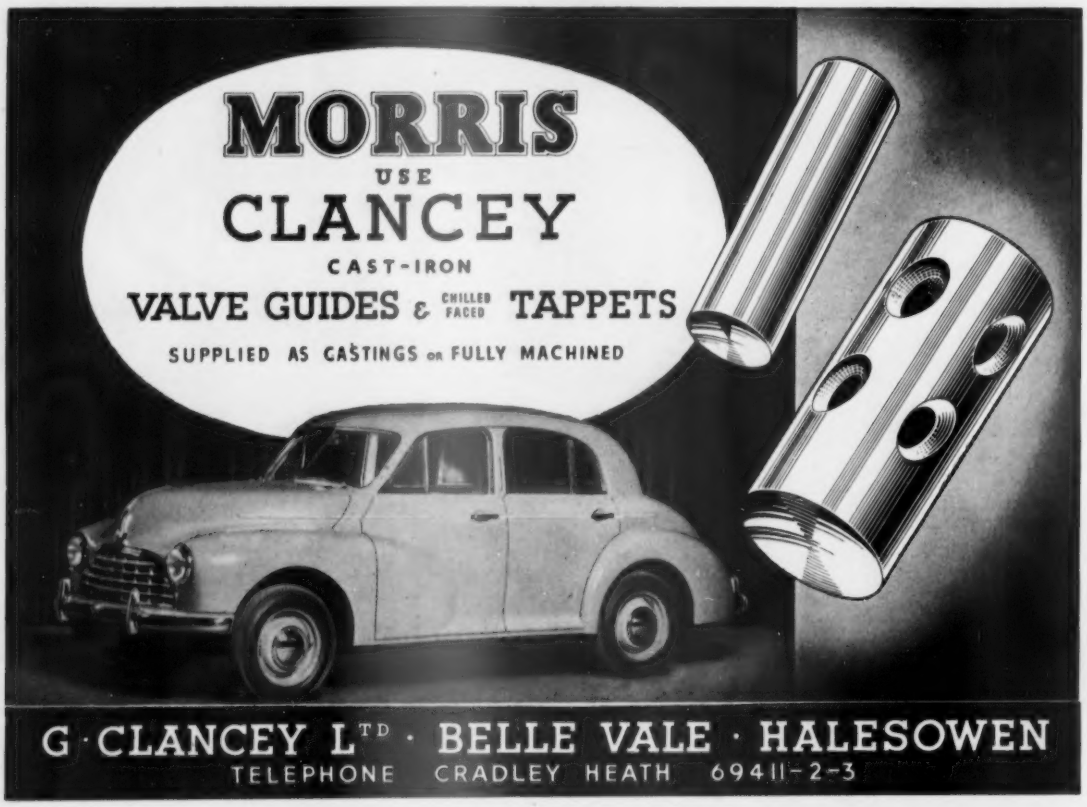

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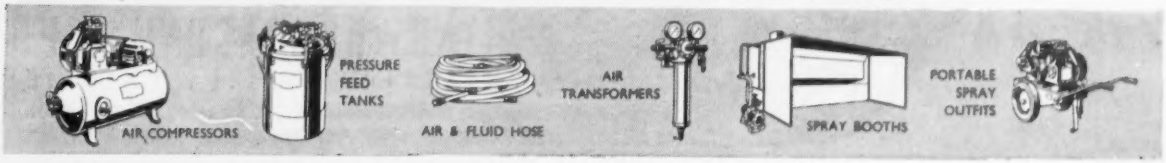

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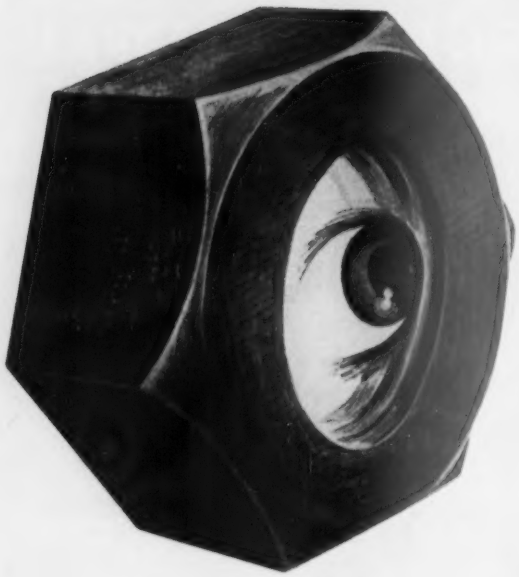

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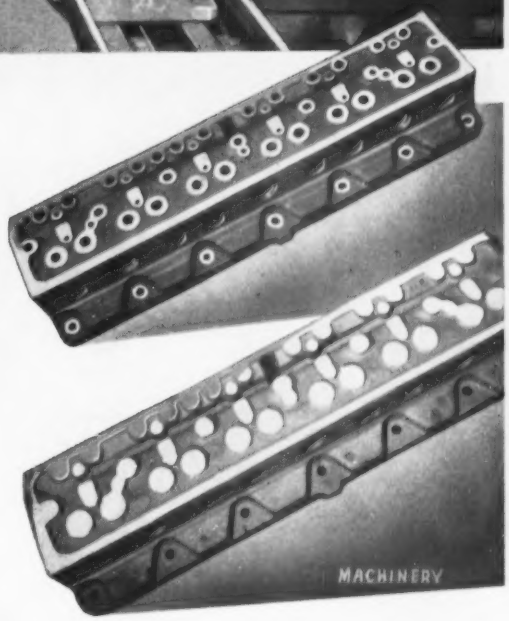

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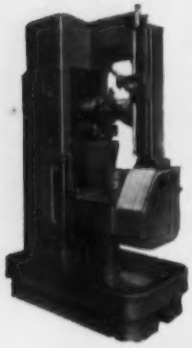

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SHAVING: 40 sec. Removing ·002/3″ from each flank.

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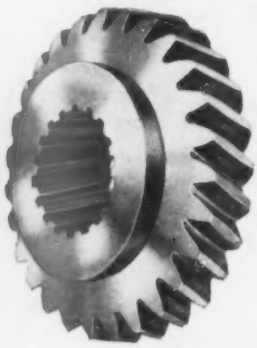

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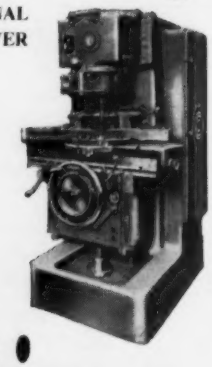

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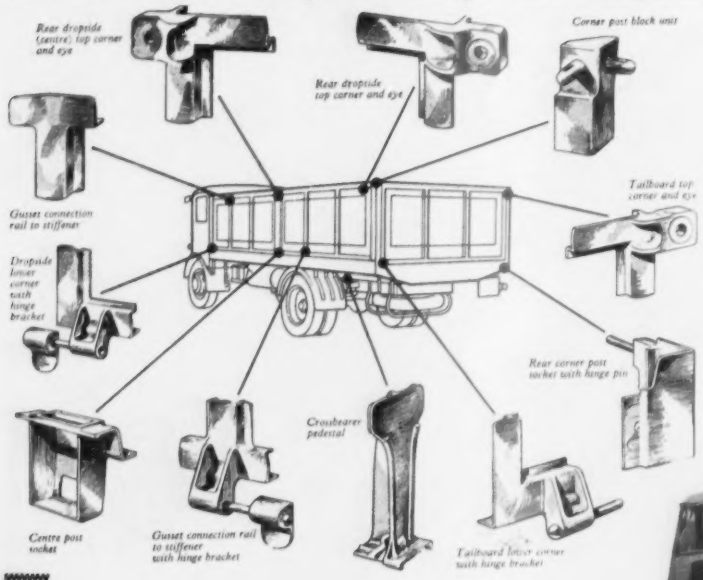
Rear dropside (centre) top corner and eye
Rear dropside top corner and eye
Corner post block unit
Gusset connection rail to stiffener
Tailboard top corner and eye
Dropside lower corner with hinge bracket
Rear corner post socket with hinge pin
Centre post socket
Gusset connection rail to stiffener with hinge bracket
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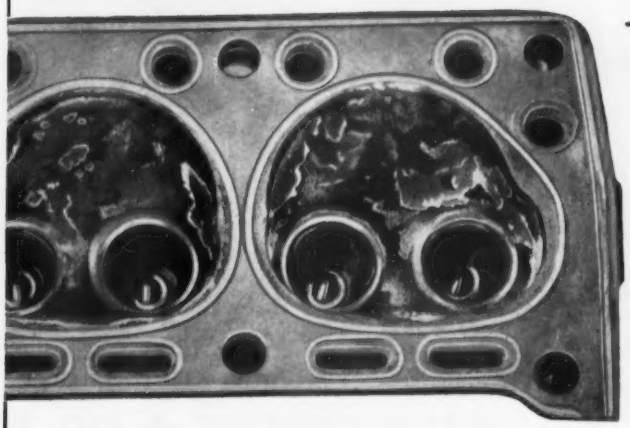

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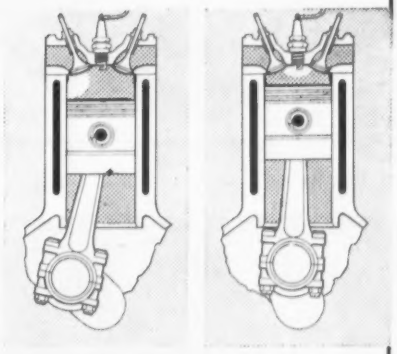

2

Sweeter running and full smooth power have already been revealed in millions of cars by I·C·A (Ignition Control Additive). This is because of I·C·A's fireproofing effect on the deposits. The diagrams show how important this is. The cylinder on the left belongs to an engine running on ordinary petrol. A glowing spot of deposit has fired the mixture too early : the engine is running roughly, wasting fuel, losing power, and possibly being damaged. In the cylinder on the right I·C·A has conditioned the deposits and firing takes place in the proper manner. The engine is now able to run as smoothly and powerfully as the maker intended.

3

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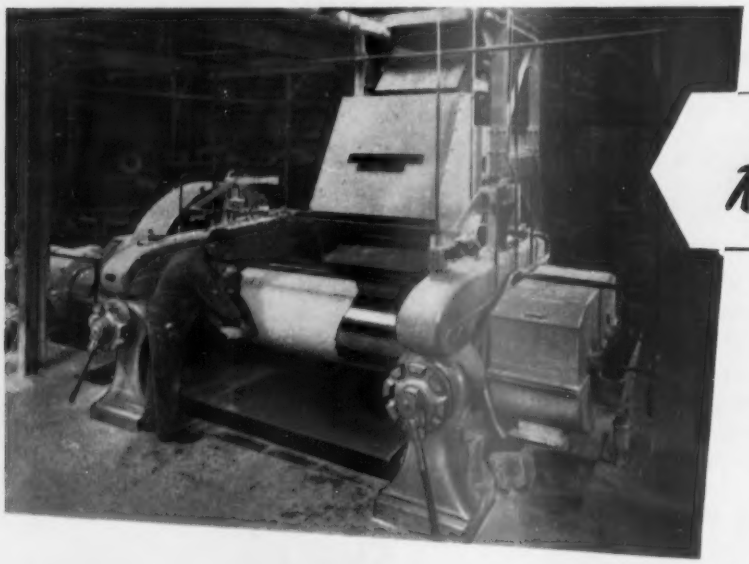

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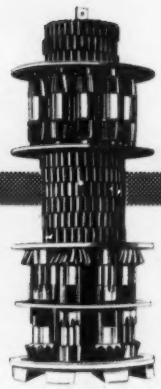

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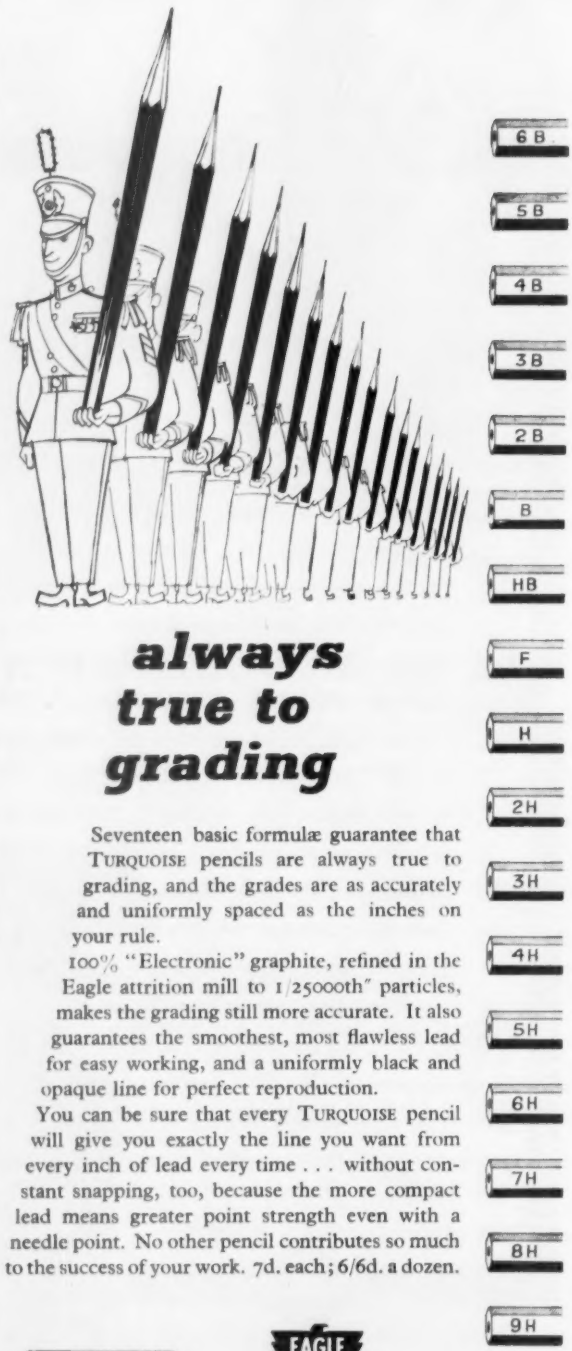

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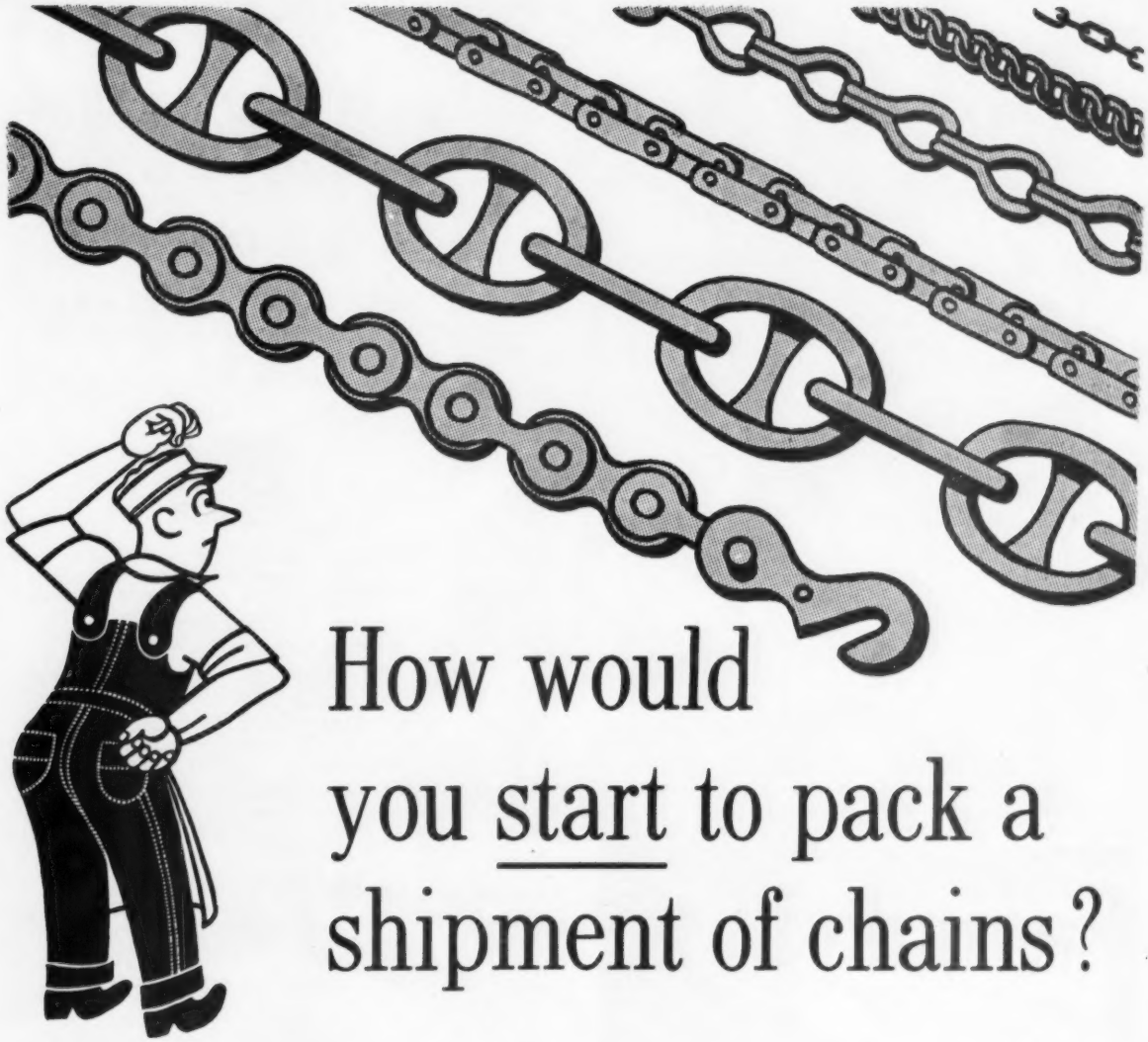

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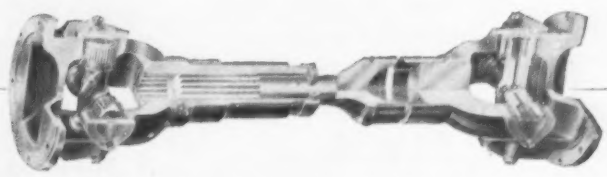

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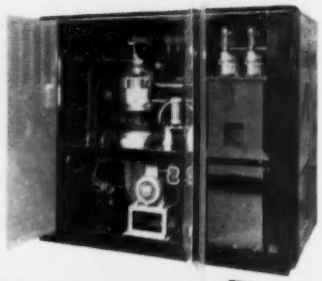

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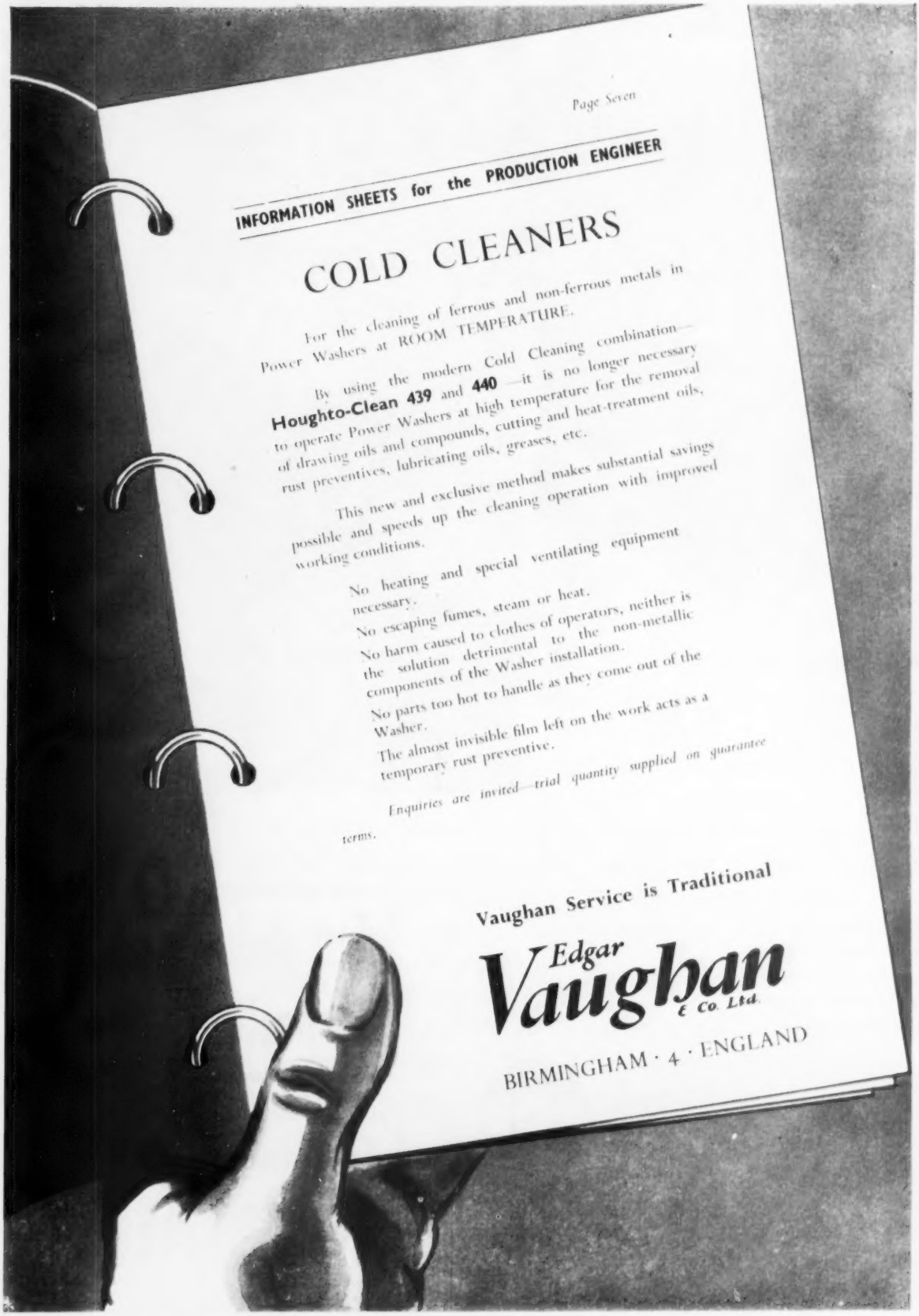
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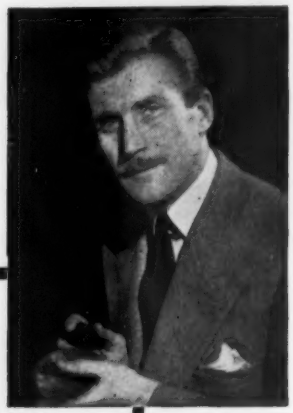

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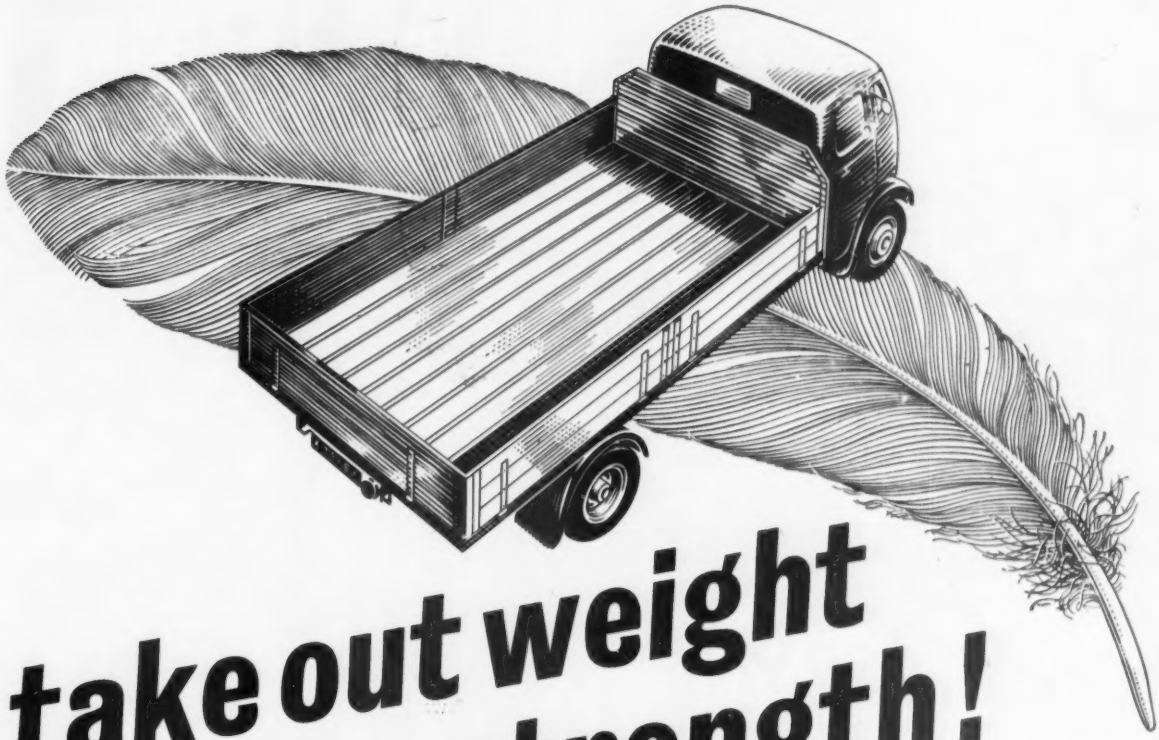

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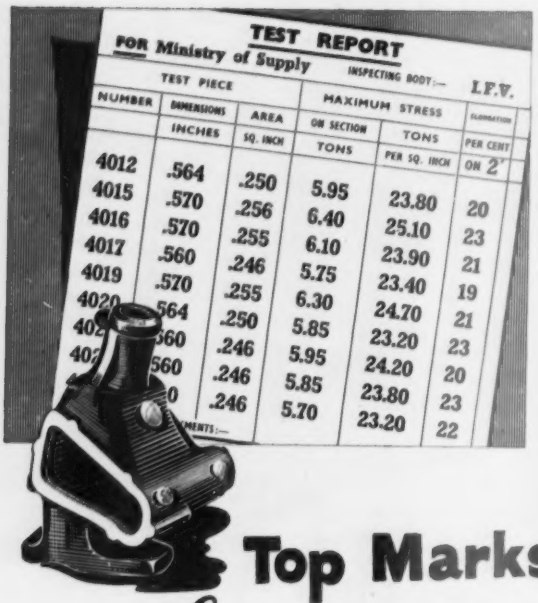

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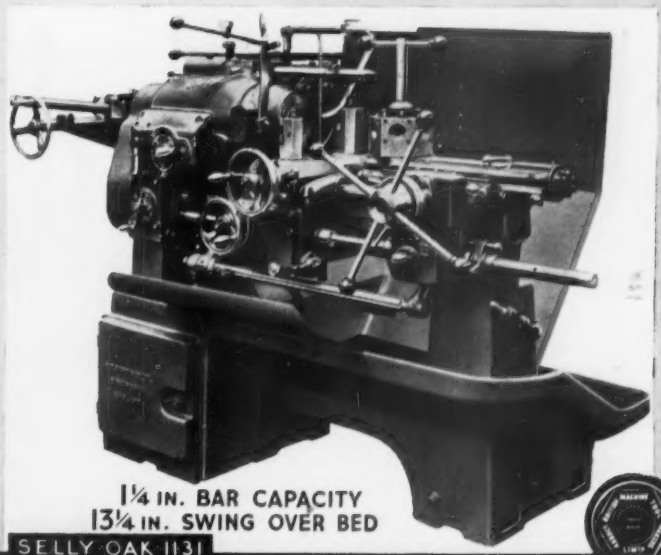

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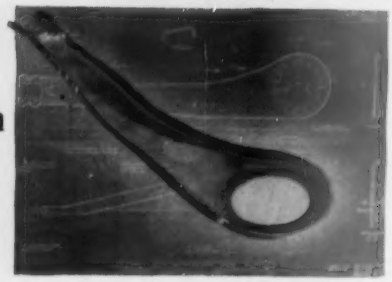

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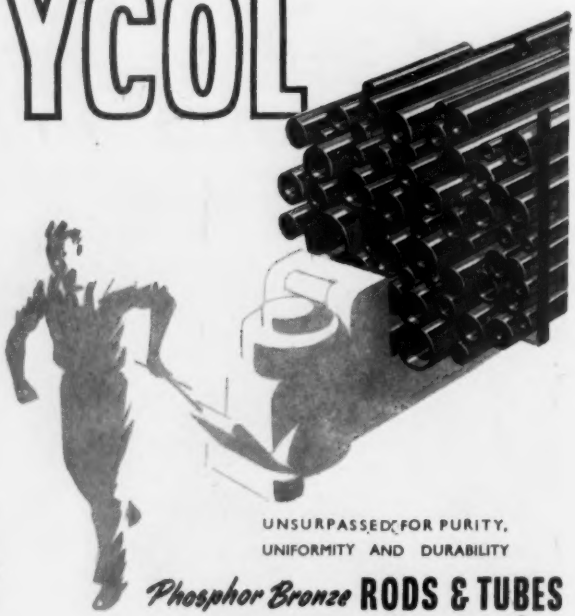

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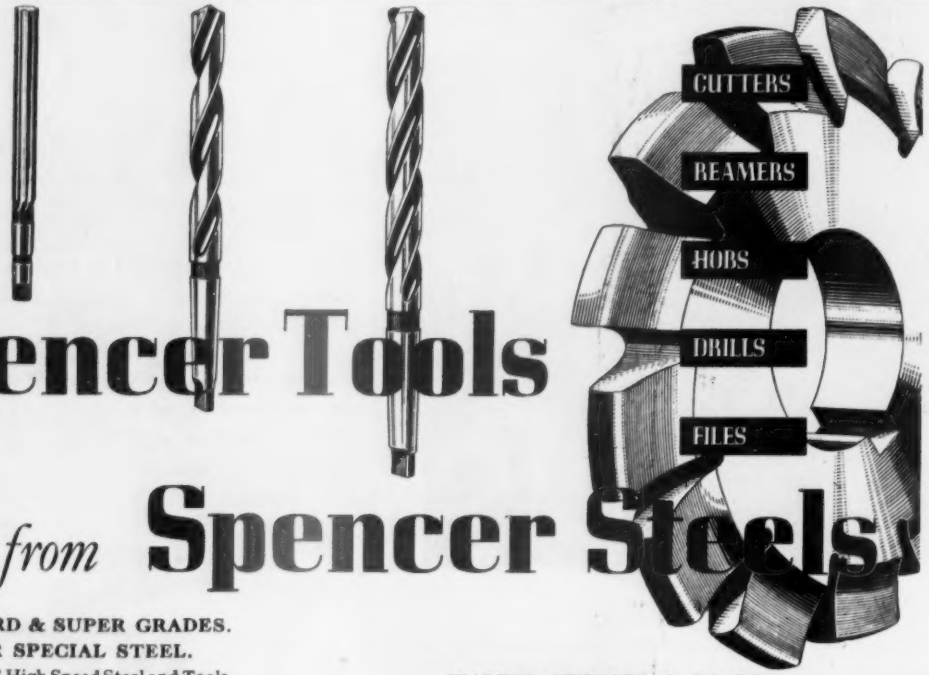

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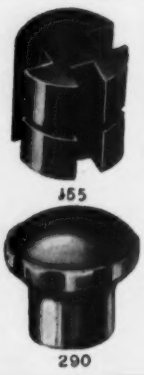

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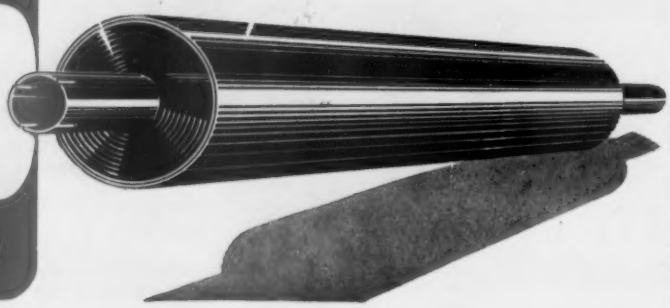

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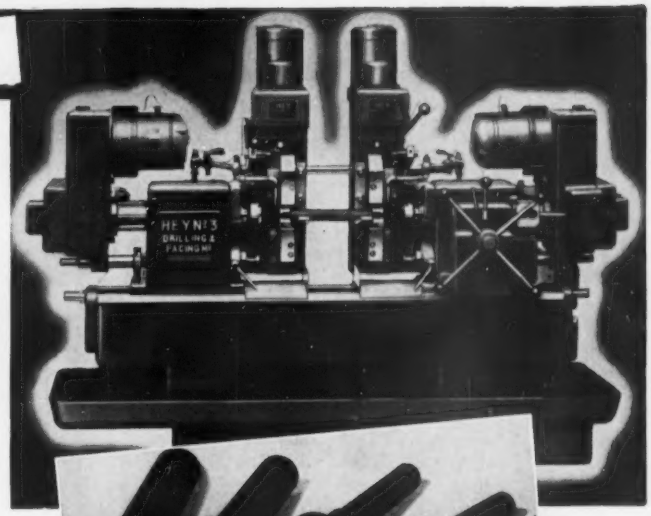

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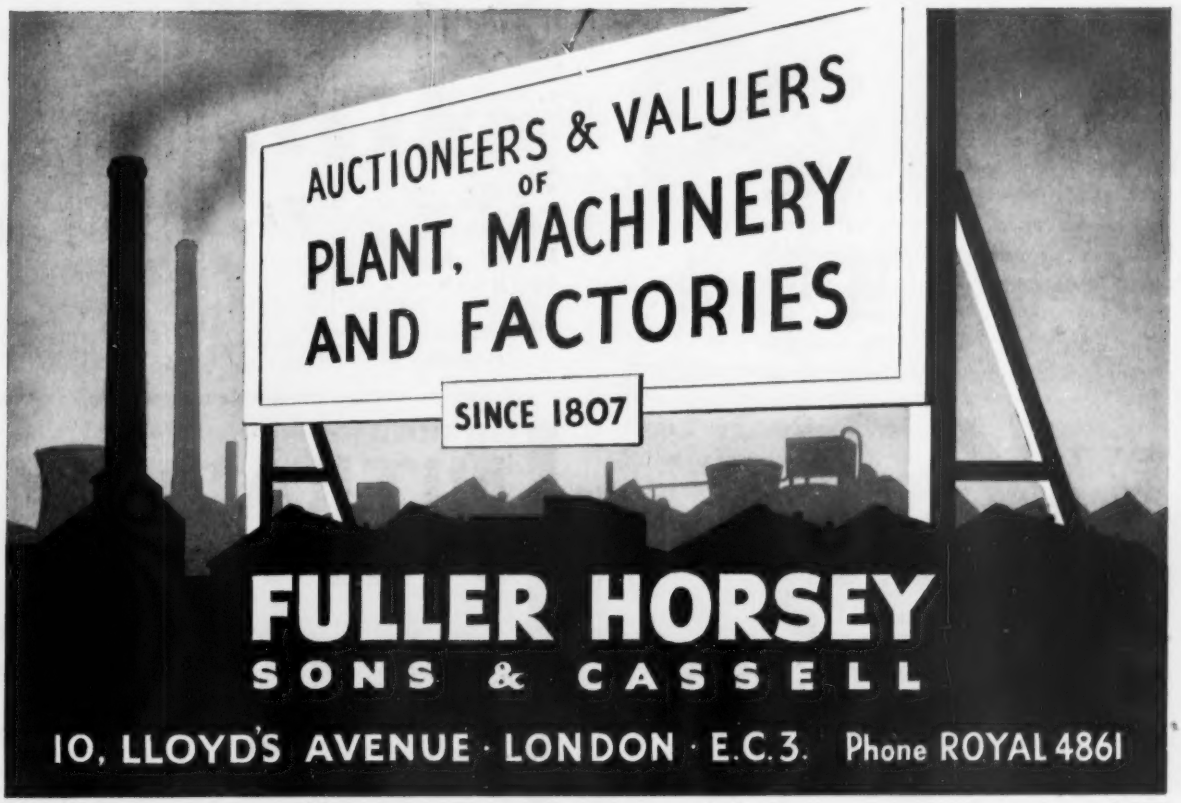

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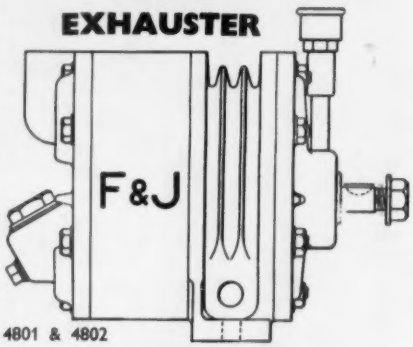

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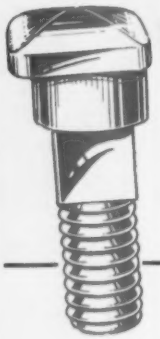

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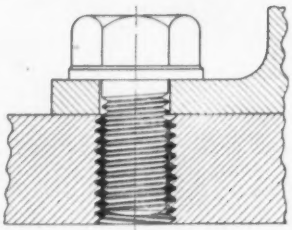

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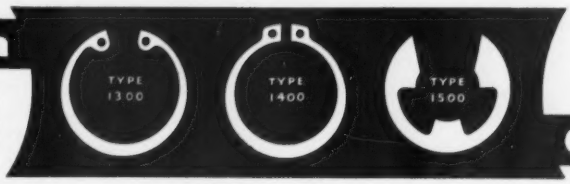

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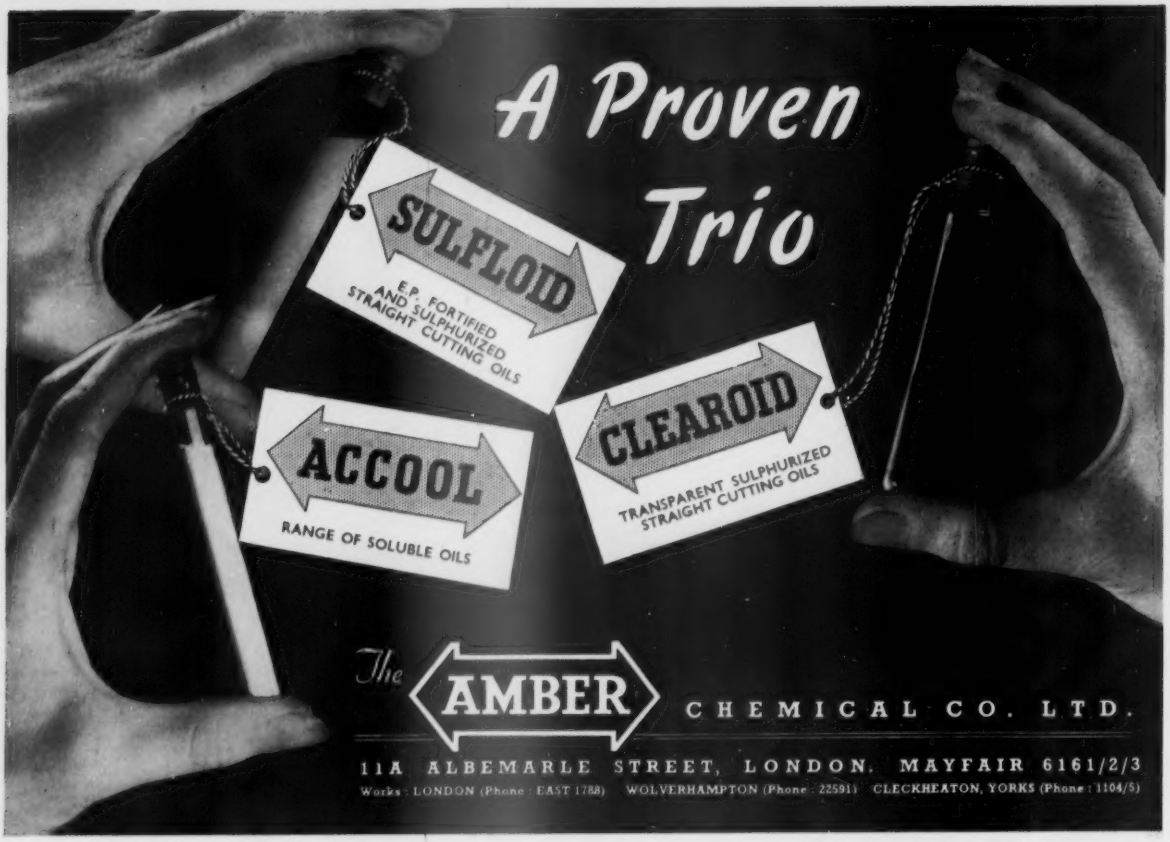
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INDEX TO MANUFACTURERS' ANNOUNCEMENTS

	PAGE
AC-Delco Division of General Motors, Ltd.	19
Acheson Colloids, Ltd.	90
Adamant Engineering Co., Ltd.	24
Aerialite, Ltd.	138
Aerograph Co., Ltd., The	117
Aero Heat Treatments, Ltd.	120
Aluminium Bronze Co., Ltd.	112
Amal, Ltd.	132
Amber Chemical Co., Ltd., The	154
Anderton Springs, Ltd.	153
Andre Rubber Co., Ltd.	15
Angus, Geo., & Co., Ltd.	79
Archdale, James & Co., Ltd.	123
Ash, Thomas & Co., Ltd.	124
Automotive Products Co., Ltd.	5, 6, 7, 8
Barber & Colman, Ltd.	146
B. B. Chemical Co., Ltd.	151
Beans Industries, Ltd.	44
B.E.N. Patents, Ltd.	110
Benton & Stone, Ltd.	120
Birlec, Ltd.	99
Birmingham Aluminium Casting (1903) Co., Ltd.	Cover iv
Birmingham Tool & Gauge Co., Ltd.	140
Black & Decker, Ltd.	55
Booth, J., & Co., Ltd.	71
Bound Brook Bearings (G.B.), Ltd.	34
Briscoe, W. H. & Co., Ltd.	128
British Electrical Development Association	Cover iii
British Oxygen Co., Ltd., The	16, 17
British Wire Products Ltd.	13
Brown, David, Corporation (Sales), Ltd., The	121
B.S.A. Tools, Ltd.	73
Burton Griffiths & Co., Ltd.	73
Bury Felt Manufacturing Co.	81
Cape Asbestos Co., Ltd., The	92, 93
Carbon Dioxide Co., The, a Division of The Distillers Company Limited	119
Carr Fastener Co., Ltd.	138
Cassell Cyanide	18
C.A.V., Ltd.	74
Chamberlain & Willows	148
Churchill, Charles & Co., Ltd.	124
Clancey, G., Ltd.	116
Clayton Crane & Hoist Co., Ltd., The	147
Clayton Dewandre Co., Ltd.	76
Clifford, Chas., Ltd.	114
Consolidated Pneumatic Tool Co., Ltd.	28
Cooper & Co. (Birmingham), Ltd.	98
Coopers Mechanical Joints, Ltd.	84
Coventry Motor Fittings Co., Ltd.	65
Cross Mfg. Co. (1938), Ltd.	153
C.T.D.(Birmingham), Ltd.	136
Dartmouth Auto Castings, Ltd.	40
Darwins, Ltd.	132
Desoutter Bros., Ltd.	51
Doncaster, Daniel & Sons, Ltd.	111
Dover, Limited	98
Dowty Seals, Ltd.	39
Dualloys, Ltd.	107
Dunford & Elliott (Sheffield), Ltd.	134
Dunlop Rubber Co., Ltd.	69
Eagle Pencil & Co., Ltd., The	130
Edwards, F. J., Ltd.	152
English Electric Co., Ltd.	150
English Steel Corporation, Ltd.	Cover ii
Enthoven Solders, Ltd.	22
Feeny & Johnson, Ltd.	150
Feltham, Walter H., & Sons, Ltd.	153
Ferodo, Ltd.	36, 37
Firth Brown Tools, Ltd.	77
Firth-Derihon (Stampings), Ltd. The	11
Firth, Thos., & John Brown, Ltd.	46
Fischer Bearings, Ltd.	27
Fletcher, Miller, Ltd.	106
Follsain Wycliffe Foundries, Ltd.	145
Fry's Metal Foundries, Ltd.	116
Fuller, Horsey, Sons & Cassell	149
Garringtons, Ltd.	150
Gauge & Toolmaker Association Exhibition	83
Girling, Ltd.	30
Glacier Metal Co., Ltd., The	125
Gloucester Railway Carriage & Wagon Co., Ltd.	41
Groves, Samuel & Co., Ltd.	142
Habershon, J. J. & Sons, Ltd.	139
Hanwell Engineering Co., Ltd., The	145
Hardy Spicer & Co., Ltd.	133
Harrison Bros. (Plastics), Ltd.	148
Herbert, Alfred, Ltd.	87
Hermetic Rubber Co., Ltd.	146
Hey Engineering Co., Ltd.	149
Hoffmann Manufacturing Co., Ltd., The	97
Holroyd, John & Co., Ltd.	23
Hughes, Geo. H., Ltd.	128
Humphreys, J. H. & Sons	132
I.C.I. (Marston Excelsior), Ltd.	122
I.C.I. (Metals), Ltd.	141
Ilford, Ltd.	20
Imperial Smelting Corporation	104
Intalok, Ltd.	62
International Harvester Co. of Great Britain Ltd., The	153
International Twist Drill Co., Ltd., The	134
"Iron & Steel Directory"	118
Jackson, H., Ltd.	86
Jenks, A. E. & Cattell, Ltd.	151
Jenolite, Ltd.	100
Jessop, Wm. & Sons, Ltd.	53
Johansson, C. E., Ltd.	103
Johnson & Johnson (Great Britain), Ltd.	136
Kendall & Gent, Ltd.	143
Kirkstall Forge Eng., Ltd.	4, 138
Lanarkshire Bolt & Rivet Co., Ltd.	122
Lathom Engineering Co., Ltd.	148
Laycock Engineering Co., Ltd.	45
Lewis Spring Co., Ltd., The	106
Ley's Malleable Castings, Ltd.	47
Linread, Ltd.	64
Lucas, Joseph (Gas Turbine Equipment), Ltd.	66
Manganese Bronze & Brass Co., Ltd.	48
Marbaix, Gaston E., Ltd.	88
Marsh Bros. & Co., Ltd.	14
Marshall, C. & C., Ltd.	140
M.C.L. and Repetition, Ltd.	152
"Mechanical Handling"	102
Mechanical Handling Exhibition	9
Mek-Elek Engineering, Ltd.	153
Metalastik, Ltd.	33
Metropolitan-Vickers Electrical Co., Ltd.	100
Midland Mechanical Developments, Ltd.	72
Midland Motor Cylinder Co., Ltd., The	25
Mills, William, Ltd.	126
Monks & Crane, Ltd.	3
Morgan Crucible Co., Ltd., The	38
Moss Gear Co., Ltd.	108
Neill, James & Co. (Sheffield), Ltd.	109
Newall, A. P. & Co., Ltd.	50
Nitralloy, Ltd.	150
Osborn, Samuel & Co., Ltd.	130
Perry Barr Metal Co., Ltd.	135
Perry Chain Co., Ltd.	140
Plessey Co., Ltd., The	58
Pollard Bearings, Ltd.	80
Precision Rubbers, Ltd.	110
Prestons, Ltd.	142
Pyrene Co., Ltd., The	10
Radio Heaters, Ltd.	136
Ransome & Marles Bearing Co., Ltd.	91
Redfern's Rubber Works, Ltd.	102
Remploy, Ltd.	131
Renold & Coventry Chain Co., Ltd., The	113
Rockwell Machine Tool Co., Ltd.	31
Rolls-Royce, Ltd.	85
R.T.S.C. Home Sales, Ltd.	29
Rubery, Owen & Co., Ltd.	49
Selson Machine Tool Co., Ltd.	70
Sheffield Twist Drill & Steel Co., Ltd., The	Cover i
Shell Mex & B.P., Ltd.	127
Shimwell & Co., Ltd.	126
Shotton Bros., Ltd.	142
Silentbloc, Ltd.	59
Simmonds Aerocessories, Ltd.	105
Skefko Ball Bearing Co., Ltd.	96
Small & Parkes, Ltd.	54
Smethwick Drop Forgings, Ltd.	89
Smith, W. H., & Son, Ltd.	134
Smiths Jacking Systems, Ltd.	78
Solex (Gauges), Ltd.	75
Specialloid, Ltd.	147
Spencer, H. F. & Co., Ltd.	35
Spencer, Walter & Co., Ltd.	148
Standard Resistance Welders, Ltd.	108
Standard Telephones & Cables, Ltd.	82
Sterling Metals, Ltd.	94
Super Oil Seals & Gaskets, Ltd.	2
Sutcliffe, Speakman & Co., Ltd.	144
Tecalemit, Ltd.	52
Terry, Herbert & Sons, Ltd.	12
Thomas, Richard, & Baldwins, Ltd.	68
Thompson, John, Motor Pressings, Ltd.	144
Tilghman's Patent Sand Blasting Co., Ltd.	104
Torrington Co., Ltd., The	115
Tucker, George, Eyelet Co., Ltd.	32
Udal, J. P., Ltd.	114
United Steel Companies, Ltd.	26
Vaughan, A. J. & Co. (Mitre Works), Ltd.	146
Vaughan Bros. (Drop Forgings), Ltd.	153
Vaughan, Edgar, & Co., Ltd.	137
Vokes, Ltd.	61
Ward, H. W. & Co., Ltd.	143
Ward, Thomas W., Ltd.	101, 112
Wellworthy Piston Rings, Ltd.	42
Weston, Chas. & Co., Ltd.	63
Whyte & Collins, Ltd.	144
Wickman, Ltd.	1, 56, 57, 67
Wiggin, Henry & Co., Ltd.	95
Wild-Barfield Electric Furnaces, Ltd.	129
Woodhead, Jonas, & Sons, Ltd.	60
Yarwood, Ingram & Co., Ltd.	118
Zinc Alloy Die Casters' Assn.	21, 43

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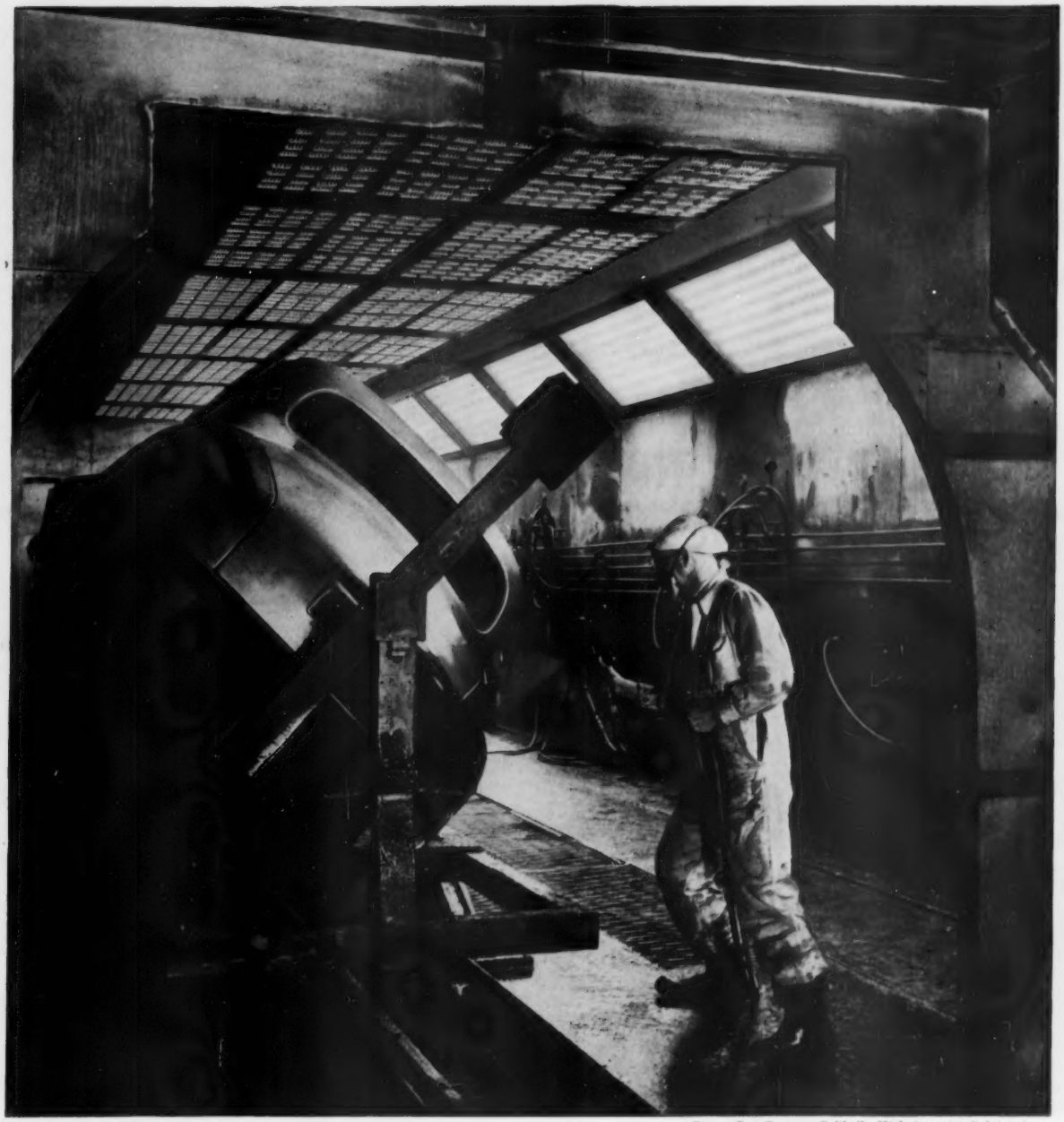

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